APPENDIX JJ:

Hardrock Mining Information

Certified Product Notification Forms. Award applicants are estimated to spend an additional 20 hours on average to complete the awards application. Burden means the total time, effort, or financial resources expended by persons to generate, maintain, retain, or disclose or provide information to or for a Federal agency. This includes the time needed to review instructions; develop, acquire, install, and utilize technology and systems for the purposes of collecting, validating, and verifying information, processing and maintaining information, and disclosing and providing information; adjust the existing ways to comply with any previously applicable instructions and requirements which have subsequently changed; train personnel to be able to respond to a collection of information; search data sources; complete and review the collection of information; and transmit or otherwise disclose the information.

The ICR provides a detailed explanation of the Agency's estimate, which is only briefly summarized here:

Estimated Number of Respondents: 357 state and local government; 1,319 private sector organizations, and 668 individuals per year.

Frequency of Response: Varies.

Estimated Total Annual Hour Burden: 57,248 hours.

Estimated Total Annual Cost: $4,665,618, including $1,793,181 in operation & maintenance costs.

Are There Changes in the Estimates From the Last Approval?

The overall burden estimate for this collection is 7,167 hours higher than the burden estimated under the current ICR because the WaterSense program has been launched and expanded since the current ICR was approved. The change in burden reflects the substantial increase in the number of products certified, new partners joining and reporting, and the addition of the New Homes portion of the program. EPA also has a better understanding of how long it takes partners to complete program forms, now that the program is underway.

What Is the Next Step in the Process for This ICR?

EPA will consider the comments received and amend the ICR as appropriate. The final ICR package will then be submitted to OMB for review and approval pursuant to 5 CFR 1320.12. At that time, EPA will issue another **Federal Register** notice pursuant to 5 CFR 1320.5(a)(1)(iv) to announce the submission of the ICR to OMB and the opportunity to submit additional comments to OMB. If you have any questions about this ICR or the approval process, please contact the technical person listed under **FOR FURTHER INFORMATION CONTACT**.

Dated: July 20, 2009.

James Hanlon,

Director, Office of Wastewater Management.

[FR Doc. E9–17927 Filed 7–27–09; 8:45 am]

BILLING CODE 6560–50–P

ENVIRONMENTAL PROTECTION AGENCY

[EPA–HQ–SFUND–2009–0265; FRL–8931–7]

RIN 2050–AG56

Identification of Priority Classes of Facilities for Development of CERCLA Section 108(b) Financial Responsibility Requirements

AGENCY: Environmental Protection Agency (EPA)

ACTION: Priority notice of action.

SUMMARY: Section 108(b) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended, establishes certain regulatory authorities concerning financial responsibility requirements. Specifically, the statutory language addresses the promulgation of regulations that require classes of facilities to establish and maintain evidence of financial responsibility consistent with the degree and duration of risk associated with the production, transportation, treatment, storage, or disposal of hazardous substances. CERCLA Section 108(b) also requires EPA to publish a notice of the classes for which financial responsibility requirements will be first developed. To fulfill this requirement, EPA is by this notice identifying classes of facilities within the hardrock mining industry for which the Agency will first develop financial responsibility requirements under CERCLA Section 108(b). For purposes of this notice, hardrock mining facilities include those which extract, beneficiate or process metals (*e.g.*, copper, gold, iron, lead, magnesium, molybdenum, silver, uranium, and zinc) and non-metallic, non-fuel minerals (*e.g.*, asbestos, gypsum, phosphate rock, and sulfur).

FOR FURTHER INFORMATION CONTACT: For more information on this notice, contact Ben Lesser, U.S. Environmental Protection Agency, Office of Resource Conservation and Recovery, Mail Code 5302P, 1200 Pennsylvania Ave., NW., Washington, DC 20460; telephone (703) 308–0314; or (e-mail) *Lesser.Ben@epa.gov;* or Elaine Eby, U.S. Environmental Protection Agency, Office of Resource Conservation and Recovery, Mail Code 5304P,1200 Pennsylvania Ave., NW., Washington, DC 20460; telephone (703) 603–844; or (e-mail) *Eby.Elaine@epa.gov.*

SUPPLEMENTARY INFORMATION:

A. How Can I Get Copies of This Document and Other Related Information?

This **Federal Register** notice and supporting documentation are available in a docket EPA has established for this action under Docket ID No. EPA–HQ–SFUND–2009–0265. All documents in the docket are listed on the *http://www.regulations.gov* Web site. Although listed in the index, some information may not be publicly available, because for example, it may be Confidential Business Information (CBI) or other information, the disclosure of which is restricted by statute. Certain material, such as copyrighted material, is not placed on the Internet and will be publicly available only in hard copy form. Publicly available docket materials are available either electronically through *http://www.regulations.gov* or in hard copy at the RCRA Docket, EPA/DC, EPA West, Room 3334, 1301 Constitution Avenue, NW., Washington, DC. The Docket Facility is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is (202) 566–1744, and the telephone number for the Superfund Docket is (202) 566–0270. A reasonable fee may be charged for copying docket materials.

B. Table of Contents

I. Introduction

Section 108(b), 42 U.S.C. 9608 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended, requires in specified circumstances that owners and operators of facilities establish evidence of financial responsibility. Specifically, it requires the promulgation of regulations that require classes of facilities to establish and maintain evidence of financial responsibility consistent with the degree and duration of risk associated with the production, transportation, treatment, storage, or disposal of hazardous substances. The section also instructs that the President:[1]

> * * * identify those classes for which requirements will be first developed and publish notice of such identification in the **Federal Register**.[2]

EPA is publishing this notice to fulfill its obligations under CERCLA Section 108(b) to identify those classes of facilities, owners, and operators (herein referred to as classes of facilities) for which financial responsibility requirements will first be developed.

For the reasons that follow, the Agency has identified classes of facilities within the hard-rock mining industry as its priority for the development of financial responsibility requirements under CERCLA Section 108(b). For purposes of this notice only, hardrock mining is defined as the extraction, beneficiation or processing of metals (*e.g.,* copper, gold, iron, lead, magnesium, molybdenum, silver, uranium, and zinc) and non-metallic, non-fuel minerals (*e.g.,* asbestos, gypsum, phosphate rock, and sulfur).[3] (*See* Section VI of this notice for a discussion of EPA's consideration of additional classes of facilities for developing financial responsibility requirements under Section 108(b) of CERCLA.)

II. EPA's Approach for Identifying Those Classes of Facilities for Which Requirements Will Be First Developed

In accordance with CERCLA Section 108(b) EPA worked to determine which classes of facilities it should identify as its priority. CERCLA Section 108(b) directs the President to "identify those classes for which requirements will be first developed and publish notice of such identification [.]" However, this simple sentence does not spell out a particular methodology by which the identification is to be made. While EPA views this statutory ambiguity as allowing substantial discretion in making the identification, EPA looked to the rest of CERCLA Section 108(b) to inform its exercise of this discretion.

Examination of CERCLA Section 108(b) as a whole reveals repeated references to the concept of "risk." The first sentence of paragraph (b)(1) refers to "requirements * * * that classes of facilities establish and maintain evidence of financial responsibility consistent with the *degree and duration of risk*" and the last sentence states that "[p]riority in the development of such requirements shall be accorded to those classes of facilities * * * which the President determines present the *highest level of risk of injury.*" Paragraph (b)(2) also states that "[t]he level of financial responsibility shall be initially established, and, when necessary, adjusted to *protect against the level of risk* which the President in his discretion believes is appropriate * * *." Accordingly, EPA chose to look for indicators of risk and its related effects to inform its selection of classes for which it would first develop requirements under CERCLA Section 108(b). As a practical method of doing so, EPA reviewed information contained in a number of studies, reports, and analyses. This review pointed to numerous factors EPA should consider. For example, typical elements in evaluating risk to human health and the environment include: the probability of release, exposure, and toxicity.[4] While some of the considerations reflect these basic elements of risk evaluation, others relate more closely to the severity of consequences that result when those risks are realized, such as the releases' duration if not prevented or quickly controlled as a result of economic factors and the exposures that can result. Therefore, EPA has chosen to evaluate the following factors: (1) Annual amounts of hazardous substances released to the environment; (2) the number of facilities in active operation and production; (3) the physical size of the operation; (4) the extent of environmental contamination; (5) the number of sites on the CERCLA site inventory (including both National Priority List (NPL) sites and non-NPL sites); (6) government expenditures; (7) projected clean-up expenditures; and (8) corporate structure and bankruptcy potential.

Toxicity is reflected in the designation of substances as CERCLA hazardous substances. Current releases of hazardous substances, number of operating facilities, the physical size of an operation, the extent of environmental contamination, and the number of sites on the CERCLA site inventory (non-NPL sites and NPL sites) are factors that can relate to the probability of a release of a hazardous substance, as well as the potential for exposure. These are discussed in detail, in Section IV of this notice. Government expenditures, projected clean-up costs, and corporate structure and bankruptcy potential can relate to the severity of the consequences as a result of releases and exposure of hazardous substances. These are discussed in Section V of this notice.

EPA's review of all these factors, as reflected in the information presented in this notice and included in the docket, makes it readily apparent that hardrock mining facilities present the type of risk that, in light of EPA's current assessment, justifies designating such facilities as those for which EPA will first develop financial responsibility requirements pursuant to CERCLA Section 108(b).[5]

III. Identification of Classes of Facilities in Hardrock Mining

For purposes of this notice, EPA has included the following classes of facilities under the general title of hardrock mining: facilities which extract, beneficiate or process metals (*e.g.* copper, gold, iron, lead, magnesium, molybdenum, silver, uranium, and zinc) and non-metallic, non-fuel minerals (*e.g.* asbestos, gypsum, phosphate rock, and sulfur).[6] As explained below, hardrock mining facilities share common characteristics, and are thus being identified as a group. At the same time, those facilities included in the definition above differ such that "hardrock mining facilities" are properly considered to encompass multiple "classes" of facilities. The various classes in this notice's definition of hardrock mining are involved in two general activities: (1) The extraction of an ore or mineral from the earth; and (2) using various beneficiation activities and processing operations to produce a targeted material product, such as a metal ingot. The operations that comprise hardrock mining (*i.e.,* extraction, beneficiation, and then processing) are all part of a sequential process of converting

[1] Executive Order 12580 delegates this responsibility to the Administrator of the U.S. Environmental Protection Agency ("EPA" or "the Agency") for non-transportation related facilities. 52 FR 2923, 3 CFR, 1987 Comp., p. 193.

[2] 42 U.S.C. 9608 (b)(1).

[3] *See* memorandum to Jim Berlow, USEPA from Stephen Hoffman, USEPA and Shahid Mahmud, USEPA. *Re:* Mining Classes Not Included in Identified Classes of Hardrock Mining. June 2009.

[4] "Risk Assessment in the Federal Government: Managing the Process." National Research Council. National Academy Press, Washington, DC. 1983.

[5] Today's identification of hardrock mining is not itself a rule, and does not create any binding duties or obligations on any party. Additional research, outreach to stakeholders, proposed regulations, review of public comments, and finalization of those regulations are needed before hardrock mining facilities are subject to any financial assurance requirements.

[6] EPA notes that this notice does not affect the current Bevill status of extraction, beneficiation and processing wastes as codified in 40 CFR 261.4(b)(7).

material removed from the earth into marketable products, even though the intermediate and end products differ. Extraction, beneficiation or processing of ores and minerals can involve similar processes across types of mining, as discussed below.

However, hardrock mining is also properly considered to encompass multiple "classes" that represent a range of activities and marketable products. Extraction differs from beneficiation and both differ from processing, and depending upon the product sought, different types of processes are used. Extraction, also called mining, is the removal of rock and other materials that contain the target ore and/or mineral. The physical processes used to accomplish this vary, but are nonetheless often shared across different types of mining. These physical processes include surface, underground, and in-situ solution mining. Overburden and waste rock are removed during surface and underground extraction processes in order to gain access to the ore. Overburden and waste rock are disposed of in dumps near the mine. The dumps may or may not be lined or covered. In-situ mining involves the recovery of the metal from the ore by circulating solutions through the ore in its undisturbed geologic state and recovering those solutions for processing. The principal environmental protection concern with in-situ mining is the control and containment of the leach solutions.

Typically the next step after extraction, beneficiation involves separating and concentrating the target mineral from the ore. There are, however, many different ways in which beneficiation can occur. Beneficiation activities generally do not change the mineral values themselves other than by reducing (*e.g.* crushing or grinding) or enlarging (pelletizing or briquetting) particle size to facilitate processing, but can involve the introduction of water, other substances, and chemicals (including hazardous substances). A common beneficiation technique is flotation. Froth flotation involves adding forced air and chemicals to an ore slurry causing the target mineral surfaces to become hydrophobic and attach to air bubbles that carry the target minerals to the top of a floatation vessel. The surface froth containing the concentrated mineral is removed, and thus separated from the other waste minerals. The remaining waste minerals are called tailings. Leaching, another beneficiation technique, involves the addition of chemicals to ores or flotation concentrates in order to dissolute the target metal. For example, solvents, such as sulfuric acid are used to leach copper and sodium cyanide is used to leach gold. Following leaching, the leftover waste product is called spent ore (in heap leaching) or tailings (in other types of leaching). There are various other beneficiation techniques and intermediate processes that are used and not described here. However, flotation and leaching are the most common techniques used in the mining industry. Tailings from beneficiation are disposed in a variety of ways, most commonly in tailing ponds. Design of tailings ponds differ and may or may not include liners, seepage control, surface water diversions, and final covers. Regardless, many tailings ponds require long-term management of waste and the impoundment dam.

Processing is the refining of ores or mineral concentrates after beneficiation to extract the target material. As with beneficiation, there are many different ways of processing the ores or mineral concentrates. For example, mineral processing operations can use pyrometallurgical techniques (the use of higher temperatures as in smelting), to produce a metal or high grade metallic mixture. Smelting generates a waste product called slag. Slag is initially placed directly on the ground to cool, and is often subsequently managed into a wide range of construction materials (*e.g.*, road bed or foundation bedding).

Both because of the ways that the facilities covered by this notice fit together, and because of the range of activities that they cover, EPA believes hardrock mining is properly identified as a group and considered to include multiple classes of facilities.

IV. Hardrock Mining—Releases and Exposure to Hazardous Substances

As discussed above, evaluations of risk typically include considerations of the probability of a release, including its potential scale and scope, the exposure potential and toxicity. EPA research indicates that the hardrock mining industry typically operates on a large scale, with releases to the environment and, in some situations, subsequent exposure of humans, organisms, and ecosystems to hazardous substances on a similarly large scale. Indeed, EPA estimates that the hardrock mining industry is responsible for polluting 3,400 miles of streams and 440,000 acres of land.[7] The U.S. Forest Service (USFS) estimates that approximately 10,000 miles of rivers and streams may have been contaminated by acid mine drainage from the metal mining industry.[8]

The Agency examined its 2007 Toxic Release Inventory (TRI), and this data revealed that the metal mining industry [9] (*e.g.*, gold ore mining, lead ore and zinc ore mining, and copper ore and nickel ore mining) releases enormous quantities of toxic chemicals, at nearly 1.15 billion pounds or approximately 28 percent of the total releases by U.S. industry that is required to report under the TRI program.[10 11] This overall percentage has remained relatively stable since 2003, ranging from 25 percent (1.07 billion pounds) of total releases in 2004 to 29 percent (1.26 billion pounds) of total releases in 2006. In 2007, the majority of releases of hazardous substances from the metal mining industry were to the land, with additional releases to both the air and surface waters. Additional releases of hazardous substances were reported to TRI from metal processing facilities (*e.g.*, primary smelting of copper) with significant releases to the air and land.

The potential for releases of and exposure to hazardous substances is also reflected in the number of active facilities operating in the U.S. While estimates of the number of active mining facilities vary, in 2004, EPA estimated that there were 1,000 metal and non-metal mineral mines and processing facilities in the U.S. Furthermore, many mining facilities have been in operation for decades and can exceed thousands of acres in size.[12] Since large mines may be operated for decades, this can extend the time frame for potential releases and exposure of hazardous substances. At individual facilities, hardrock mining operations

[7] U.S. EPA. 2004. "Cleaning Up the Nation's Waste Sites: Markets and Technology Trends." EPA 542–R–04–015. Accessed at: *http://www.epa.gov/tio/pubisd.htm.*

[8] U.S. EPA 2004. "Nationwide Identification of Hardrock Mining Sites." Office of Inspector General. Report No. 2004–P–00005. Accessed at: *http://epa.gov/oig/reports/2004/20040331-2004-p-00005.pdf.*

[9] Metal mining industry is defined as NAICS Code 2122 (Metal Mining).

[10] U.S. EPA 2009. Toxic Release Inventory, 2007 Updated Data Releases, as of March 19, 2009.

[11] TRI estimates include all on-site and off-site releases to the land, air and surface water, including those disposed of in RCRA Subtitle C hazardous waste land disposal units and Safe Drinking Water Act (SDWA) permitted underground injection (UIC) wells. However, less than one percent of hazardous substances are managed in this manner. Thus, the data demonstrates the enormous volume of hazardous chemical releases reported to TRI by the metal mining industry and is an indication of the high volume of hazardous substances it manages, and the industry's potential for posing health and environmental risk.

[12] National Research Council. 2005. *Superfund and Mining Megasites: Lessons from the Coeur d'Alene River Basin.* The National Academies Press, Washington, DC. Accessed at: *http://www.nap.edu/catalog.php?record_id=11359.*

may disturb thousands of acres of land and impact watersheds including, to varying degrees, effects on groundwater, surface water, aquatic biota, aquatic and terrestrial vegetation, wetlands, wildlife, soils, air, cultural resources, and humans that use these resources recreationally or for subsistence.[13]

Hardrock mining facilities also generate an enormous volume of waste, which may increase the risk of releases of hazardous substances. Annually, hardrock mining facilities generate between one to two billion tons of mine waste.[14] This waste can take a variety of forms, including mine water, waste rock, overburden, tailings, slag, and flue dust and can contain significant quantities of hazardous substances. The 2007 TRI data demonstrate that hardrock mining facilities reported large releases of many hazardous substances, including ammonia, benzene, chlorine, hydrogen cyanide, hydrogen fluoride, toluene, and xylene, as well as heavy metals and their compounds (*e.g.,* antimony, arsenic, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, vanadium and zinc).[15] Similarly, the National Research Council (NRC) has indicated that hazardous substances of particular concern include heavy metals, ammonia, nitrates, and nitrites.[16]

These releases, in some cases, have lead to ground and surface water contamination from acid mine drainage and metal leachate, and air quality issues resulting from heavy metal-contaminated dust or emissions of gaseous metals from thermal processes.[17] Acid mine drainage is the formation and movement of acidic water which dissolves and transports metals into the environment. This acidic water forms through the chemical reaction of surface water (rainwater, snowmelt, pond water) and shallow subsurface water with rocks (*e.g.,* waste rock, tailings, mine walls) that contain sulfur-bearing minerals, resulting in the production of sulfuric acid. Metals can be leached from rocks that come in contact with the acid, a process that may be substantially enhanced by bacterial action.[18] The resulting acidic and metal-contaminated fluids may be acutely or chronically toxic and, when mixed with groundwater, surface water and soil, may have harmful effects on humans, fish, animals, and plants.[19] When acid mine drainage occurs, it is extremely difficult and often expensive to control and often requires long-term management measures.[20] Air, land and water contamination may also result when waste rock dumps, tailings disposal facilities and open pits are not maintained properly and there are releases of hazardous substances to the environment.[21] Additional risks can occur with the use of cyanide in gold mining operations, including the possible release of cyanide into soil, groundwater, and/or surface waters or catastrophic cyanide spills.[22] Contaminants of concern at uranium mines include radionuclides. Due to the volume of the hazardous substances generated and released and the potential for long-term management of acid mine drainage, the cause for concern is only heightened.

Other studies and EPA's analysis of NPL data also underscores the risk of hardrock mining facilities. The NPL is a list of national priorities among the known or threatened releases of hazardous substances, pollutants or contaminants throughout the U.S. The Hazard Ranking System (HRS), the scoring system EPA uses to assess the relative threat associated with a release from a site, is the primary method used to determine whether a site should be placed on the NPL.[23] The HRS takes into account the three elements of environmental and human health risk: (1) Probability of release; (2) exposure; and (3) toxicity. EPA generally will list sites with scores of 28.50 or above. The HRS is a proven tool for evaluating and prioritizing the releases that may pose threats to human health and the environment throughout the nation. In 2005, the NRC noted that at the largest mining sites, or mega sites (*i.e.,* those with projected cleanup costs exceeding $50 million), "wastes* * * are dispersed over a large area and deposited in complex hydrogeochemical and ecologic systems that often include human communities and public natural resources." [24] For example, a molybdenum mine located near Questa, New Mexico, began operations in 1919 and some underground mining operations are still in operation today. The mine's operational capacity is reportedly 20,000 tons of ore processed at the facility per day, although it does not typically operate at capacity. The site stretches over approximately three square miles of land. Across this large area, operations include an underground mine, a milling facility, a nine-mile long tailings pipeline and a tailing disposal facility. There is also an open pit and waste rock dumps at the mine site, which were created during open-pit mining operations. Other problems at the site include subsidence areas with a surface depression from active underground operations.[25]

In 2004, EPA's Office of Inspector General (OIG) examined 156 hardrock mining sites that are part of the CERCLA site inventory and concluded that ecological and environmental risks are often substantial. For the 82 Non-NPL sites that were evaluated, 64 percent had a current high or medium ecological/environmental risk, while the percentage of sites that were found to have low risk was only 13%. Another 23% had an unknown level of risk.[26]

In support of this notice, EPA examined not only sites listed on the

[13] National Research Council. 1999. *Hardrock Mining on Federal Lands.* National Academies Press. Washington, DC.

[14] U.S. EPA 2004. "Cleaning Up the Nation's Waste Sites: Markets and Technology Trends." EPA 542–R–04–015. Accessed at: *http://www.epa.gov/tio/pubisd.htm.*

[15] *See* Memorandum to the Record: Toxic Release Inventory (TRI) Releases from Hardrock Mining Operations. June 2009.

[16] National Research Council. 1999. Hardrock Mining on Federal Lands. National Academies Press. Washington, DC. Also, EPA conducted a preliminary review of the Records of Decisions (RODs) for a selected group mining NPL sites. These substances were found to be common contaminants at these sites. Accessed at *http://books.nap.edu/catalog.php?record_id=9682.*

[17] U.S EPA. 2004. "Cleaning Up the Nation's Waste Sites: Markets and Technology Trends." EPA 542–R–04–015. Accessed at: *http://www.epa.gov/tio/pubisd.htm.*

[18] U.S. EPA. 1997. "EPA's National Hardrock Mining Framework." Accessed at: *http://www.epa.gov/owm/frame.pdf.*

[19] U.S. EPA 2009. Accessed at: *http://www.epa.gov/nps/acid_mine.html.*

[20] The conventional approach to treating contaminated ground or surface water produced through acid drainage involves an expensive, multi-step process that pumps polluted water to a treatment facility, neutralizes the contaminants in the water, and turns these neutralized wastes into sludge for disposal. U.S. EPA. Profile of the Metal Mining Industry. September 1995. *See also:* Lind, Greg. 2007. Testimony to the Subcommittee on Energy and Mineral Resources of the Committee on Natural Resources, U.S. House of Representatives, One Hundred Tenth Congress. Serial No. 110–46.

[21] U.S. EPA. 2004. "Cleaning Up the Nation's Waste Sites: Markets and Technology Trends." EPA 542–R–04–015. Accessed at: *http://www.epa.gov/tio/pubisd.htm.*

[22] U.S. EPA. 2004. "Cleaning Up the Nation's Waste Sites: Markets and Technology Trends." EPA 542–R–04–015. Accessed at: *http://www.epa.gov/tio/pubisd.htm.*

[23] U.S. EPA. 2007. "Introduction to the Hazard Ranking System (HRS)." Accessed at: *http://www.epa.gov/superfund/programs/npl_hrs/hrsint.htm.*

[24] National Research Council. 2005. *Superfund and Mining Megasites: Lessons from the Coeur d'Alene River Basin.* The National Academies Press, Washington, DC. Accessed at: *http://www.nap.edu/catalog.php?record_id=11359.*

[25] USEPA Administrative Order on Consent for Molycorp RI/FS (2001). Molycorp is proposed for listing on the NPL. More information is at *http://www.epa.gov/region6/6sf/pdffiles/0600806.pdf.*

[26] U.S. EPA 2004. "Nationwide Identification of Hardrock Mining Sites." Office of Inspector General. Report No. 2004–P–00005, Figure 4.2. Accessed at: *http://epa.gov/oig/reports/2004/20040331-2004-p-00005.pdf.*

NPL, but also sites proposed (including sites with Superfund alternative approach agreements in place) and deleted from the NPL.[27] As of April, 2009, approximately 90 hardrock mining sites have been listed on the NPL, and another 20 facilities have been proposed for inclusion on the list.[28]

V. Hardrock Mining—Severity of Consequences Resulting From Releases and Exposure to Hazardous Substances

The severity of the consequences impacting human health and the environment as a result of releases and exposure of hazardous substances is evident by analyzing a number of factors. Specifically, the past and estimated future costs associated with protecting public health and the environment through what is often extensive and long-term reclamation and remediation efforts, as well as corporate structure and bankruptcy potential. This information also plays a significant role in leading EPA to conclude that classes of facilities involved in hardrock mining should be the first for which financial assurance requirements are developed under CERCLA Section 108(b).

The severity of consequences posed by hardrock mining facilities is evident in the enormous costs associated with past and projected future actions necessary to protect public health and the environment, after releases from hardrock mining facilities occur. In other words, the documented expenditures reflect efforts to correct the realized risks from hardrock mining facilities. As noted earlier, these facilities release large quantities of hazardous substances, often over hundreds of square miles and, in some instances, have resulted in groundwater and surface water contamination that requires long-term management and treatment. Remediation of these hardrock mining facilities has therefore been historically costly. EPA's past experience with these sites leads it to conclude that hardrock mining facilities are likely to continue to present a substantial financial burden that could be met by financial responsibility requirements. These enormous expenditures have been documented in a United States Government Accountability Office (GAO) study, and EPA's own data confirm the large amounts of money spent by the Federal government alone. The GAO, in its report "Current Government Expenditures to Cleanup Hard Rock Mining Sites," reported that in total, the Federal government spent at least $2.6 billion to remediate hardrock mine sites from 1998 to 2007. EPA spent the largest amount at $2.2 billion, with the USFS, the Office of Surface Mining, and the Bureau of Land Management spending $208 million, $198 million, and $50 million, respectively.[29] EPA's expenditure data show that between 1988 and 2007, for mining sites with response actions taken under EPA removal and remedial authorities (including sites proposed, listed, and deleted from the NPL and sites with Superfund alternative approach agreements in place), approximately $2.7 billion was spent.[30] [31] Of this total, $2.4 billion was spent at the 84 sites listed as final on the NPL list at that time.[32]

Estimated costs of remediation for all hardrock mining facilities from several sources have generally been in the range of billions of dollars. EPA has estimated that the cost of remediating all hardrock mining facilities is between $20 and $54 billion. EPA's analysis showed that if the total Federal, State, and potentially responsible party outlays for remediation were to continue at existing levels ($100 to $150 million annually), no more than eight to 20 percent of all cleanup work could be completed within 30 years.[33] In another analysis based on a survey of 154 large sites, EPA's OIG projected that the potential total hardrock mining remediation costs totaled $7 to $24 billion. OIG calculated that this amount is over 12 times EPA's total annual Superfund budget of about $1.2 billion from 1999 to 2004.[34] The annual Superfund budget from 2004 through 2008 remained consistent with OIG's assessment, at approximately $1.25 billion.[35] [36]

Common corporate structures and interrelated corporate failures within the hardrock mining industry increase the likelihood of uncontrolled releases of hazardous substances being left unmanaged, increasing risks. To begin with, mine ownership is typically complex, with individual mines often separately incorporated.[37] The existence of a parent-subsidiary relationship can present several risks. First, corporate structures may allow parent

[27] A significant number of response actions have been taken by several Federal agencies at hardrock mining facilities under CERCLA removal and emergency response authorities. Those actions were not evaluated for purposes of this Notice because of the lack of immediately available data. EPA alone took non-NPL removal actions at 99 mining sites between 1988 and October 2007. Provided to GAO for GAO 2008, "Hardrock Mining: Information on Abandoned Mines and Value and Coverage of Financial Assurance on BLM Land." GAO–08–574T. Other Federal agencies also use non-NPL removal authorities to address releases from mining sites. Accessed at: *http://www.gao.gov/highlights/d08574thigh.pdf.*

[28] Provided to GAO for GAO 2008, "Hardrock Mining: Information on Abandoned Mines and Value and Coverage of Financial Assurance on BLM Land." GAO–08–574T. Accessed at: *http://www.gao.gov/new.items/d08574t.pdf.* and updated to reflect sites finalized on the NPL in 2008 and 2009. The 2008 and 2009 NPL updates can be found at: *http://www.epa.gov/superfund/sites/npl/status.htm.*

[29] U.S. Government Accountability Office. 2008. "Information on Abandoned Mines and Value and Coverage of Financial Assurance on BLM Land." GAO–08–574T. Accessed at: *http://www.gao.gov/highlights/d08574thigh.pdf.*

[30] Moreover, EPA's cost data likely underestimates true cleanup costs, because they do not include costs borne by the States and potentially responsible parties. These costs only reflect expenditures to date. To reach construction completion, many sites will require additional, substantial remediation efforts. In addition, sites with acid mine drainage may require water quality treatment in perpetuity. Lind, Greg. 2007. Testimony to the Subcommittee on Energy and Mineral Resources of the Committee on Natural Resources, U.S. House of Representatives, One Hundred Tenth Congress. Serial No. 110–46.

[31] U.S. EPA. 2007. Superfund eFacts Database. Accessed: October 24, 2007; U.S. Environmental Protection Agency. 2007 Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS). Provided to GAO for their report, GAO 2008, "Hardrock Mining: Information on Abandoned Mines and Value and Coverage of Financial Assurance on BLM Land." GAO–08–574T. Accessed at: *http://www.gao.gov/highlights/d08574thigh.pdf.*

[32] U.S. EPA. 2007. Superfund eFacts Database. Accessed: October 24, 2007; U.S. Environmental Protection Agency. 2007 Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS). Provided to GAO for their report, GAO 2008, "Hardrock Mining: Information on Abandoned Mines and Value and Coverage of Financial Assurance on BLM Land." GAO–08–574T, *http://www.gao.gov/new.items/d08574t.pdf.*

[33] U.S. EPA. 2004. "Cleaning Up the Nation's Waste Sites: Markets and Technology Trends." EPA 542–R–04–015. Accessed at: *http://www.epa.gov/tio/pubisd.htm.*

[34] U.S. EPA 2004. "Nationwide Identification of Hardrock Mining Sites." Office of Inspector General. Report No. 2004–P–00005. Accessed at: *http://epa.gov/oig/reports/2004/20040331-2004-p-00005.pdf.*

[35] Appropriation amounts reflect an average of the discretionary appropriation amounts in the President's Budget or Operating Plan between 2004 and 2008.

[36] No single source provides information on estimated future reclamation and remediation costs for hardrock mining facilities. In addition, for those estimates that do exist, remediation costs are often folded in with other reclamation activities, such as correcting safety hazards and landscaping, which leaves the amount attributable to remediation unknown. *See* U.S. EPA. 2004. "Cleaning Up the Nation's Waste Sites: Markets and Technology Trends." EPA 542–R–04–015. Accessed at: *http://www.epa.gov/tio/pubisd.htm.*

[37] For example, one mining company's 2008 SEC 10–K filing noted that its segments included "The Greens Creek unit, a 100%-owned joint venture arrangement, through our subsidiaries Hecla Alaska LLC, Hecla Greens Creek Mining Company and Hecla Juneau Mining Company. We acquired 70.3% of our ownership of Greens Creek in April 2008 from indirect subsidiaries of Rio Tinto, PLC." From this description, it appears that ownership of the mine has involved multiple subsidiaries, under both its current owner and under the previous ownership.

corporations to shield themselves from liabilities of their subsidiaries.[38] In a 2005 study, the GAO cited mining facilities as an example of businesses at risk of incurring substantial liability and transferring the most valuable assets to the parent that could not be reached for cleanup.[39]

Second, many mining interests are located outside of the U.S. According to one report, six of the top ten mining claim owners in the U.S. are multi-national corporations with headquarters outside the U.S.[40] Such multi-national corporations can be difficult to hold responsible for contamination in the U.S. because of the difficulties of locating and then obtaining jurisdiction over the ultimate parent company.

This is of particular concern since the hardrock mining industry has experienced a pattern of failed operations, which often require significant environmental responses that cannot be financed by industry.[41] The pattern of failed operations has been well documented. GAO investigated 48 hardrock mining operations on U.S. Department of Interior (DOI), Bureau of Land Management (BLM) Federal lands that had ceased operations and not been reclaimed by operators since BLM began requiring financial assurance under its regulations. Of the 48 operations, 30 cited bankruptcy as the reason for completing reclamation activities.[42] Numerous other examples exist of bankruptcies in the hardrock mining industry that resulted in or will likely require significant Federal responses, such as:

- When the owner/operator filed for bankruptcy in 1992, it left the Summitville mine in Colorado with serious cyanide contamination and acid mine drainage. In 1994, the site was listed on the NPL. In 2000, EPA estimated that the remediation cost at the mine would be $170 million.[43] As of October 2007, EPA had spent approximately $192 million in cleanup costs.[44]
- In 1999, another mining company filed for bankruptcy, leaving more than 100 million gallons of contaminated water and millions of cubic yards of waste rock at the Gilt Edge Mine in South Dakota.[45] EPA listed the site on the NPL in 2000 and estimated at that time the present value remediation costs to be $50.3 million.[46] Even this estimate, however, does not include water collection and treatment costs that will be handled under additional remediation plans. As of October 2007, EPA expenditures at this site exceeded $56.1 million.[47]
- In 1998, operators of the Zortman Landusky mine in Montana filed for bankruptcy. Numerous cyanide releases occurred during operations which have affected the community drinking water supply on a nearby Tribal reservation. Acid mine drainage has also permeated the ground and surface waters. The projected cleanup costs at the site are estimated to be approximately $85.2 million, of which only $57.8 million will be paid for by the responsible party. State and Federal authorities are projected to pay the remaining $27.4 million for cleanup.[48]
- A large mining company filed for bankruptcy in 2005. The company has estimated the total environmental claims filed against it to have been in excess of $5 billion. Recently approved settlements with the U.S. and certain State governments involving environmental clean-up claims, when combined with settlements already approved by the bankruptcy court for environmental clean-up claims, provide for allowed claims and payments in the bankruptcy in an amount in excess of $1.5 billion and involve in excess of 50 sites. EPA and DOI estimate their combined claims in the bankruptcy at the largest of these sites, an NPL site located in Idaho and Eastern Washington, to be in excess of $2 billion.[49]

Taking all this information into account, EPA concludes that classes of facilities within the hardrock mining industry are those for which EPA should first develop financial responsibility requirements under CERCLA Section 108(b), based upon those facilities' sheer size; the enormous quantities of waste and other materials exposed to the environment; the wide range of hazardous substances released to the environment; the number of active hardrock mining facilities; the extent of environmental contamination; the number of sites in the CERCLA site inventory, government expenditures, projected clean-up costs and corporate structure and bankruptcy potential.

VI. EPA's Consideration of Additional Classes of Facilities for Developing Financial Responsibility Requirements

The Agency believes classes of facilities outside of the hardrock mining industry also may warrant the development of financial responsibility requirements under CERCLA Section 108(b). Therefore, the Agency will continue to gather and analyze data on additional classes of facilities, beyond the hardrock mining industry, and will consider them for possible development of financial responsibility requirements. In determining whether to propose requirements under CERCLA Section 108(b) for such additional classes of facilities, EPA will consider the risks posed and, to do so, may take into account factors such as: (1) The amounts of hazardous substances released to the environment; (2) the toxicity of these substances; (3) the existence and proximity of potential receptors; (4) contamination historically found from facilities; (5) whether the causes of this contamination still exist; (6) experiences from Federal cleanup programs; (7) projected costs of Federal cleanup programs; and (8) corporate structures and bankruptcy potential. EPA also intends to consider whether financial responsibility requirements under CERCLA Section 108(b) will effectively reduce these risks. While the Agency recognizes that data for some of these factors may be unavailable or limited in

[38] *See U.S.* v. *Bestfoods,* 524 U.S. 51, 61 (1998) ("[i]t is a general principle of corporate law * * * that a parent corporation * * * is not liable for the acts of its subsidiaries.")

[39] U.S. Government Accountability Office. 2005. "Environmental Liabilities: EPA Should Do More to Ensure That Liable Parties Meet Their Cleanup Obligations." Report to Congressional Requesters. GAO–05–658, pp. 21–24. Accessed at: *http://www.gao.gov/highlights/d05658high.pdf.*

[40] Environmental Working Group. 2006. "Who Owns the West?" Accessed at: *http://www.ewg.org/mining/claims/index.php.*

[41] EPA notes that there are several potential explanations for these failures, such as a boom and bust cycle in the price of commodities, the finite life of a particular ore body or the possibility that closure or reclamation obligations exceed the remaining value of the operation, in addition to factors that can cause bankruptcies in other sectors. However, regardless of the cause, the fact remains a large number of bankruptcies and abandonments have occurred.

[42] U.S. Government Accountability Office. 2005. Hardrock Mining: BLM Needs to Better Manage Financial Assurances to Guarantee Coverage of Reclamation Costs. GAO–05–377. Accessed at: *http://gao.gov/products/GAO-05-377.*

[43] U.S. Environmental Protection Agency. 2000. *Liquid Assets 2000: America's Water Resources at a Turning Point.* EPA–840–B–00–001. Accessed at: *http://www.epa.gov/water/liquidassest.pdf.*

[44] U.S. Environmental Protection Agency. 2007. Superfund eFacts Database. Accessed: October 24, 2007.

[45] CDM. 2008. Final Feasibility Study Report for the Gilt Edge Superfund Site, Operable Unit 1 (OU1). Prepared for EPA, Region VIII. May 2008.

[46] U.S. EPA 2008. Record of Decision for the Gilt Edge Superfund Site Operable Unit 1 (OU1). Accessed at: *http://www.epa.gov/region8/superfund/sd/giltedge/RODGiltEdgeVolumeOne_Text.pdf.*

[47] U.S. EPA. 2007. Superfund eFacts Database. Accessed: October 24, 2007.

[48] U.S. Government Accountability Office. 2005. Hardrock Mining: BLM Needs to Better Manage Financial Assurances to Guarantee Coverage of Reclamation Costs. GAO–05–377. Accessed at: *http://gao.gov/products/GAO-05-377.*

[49] Asarco, LLC, *et al.* U.S. Bankruptcy Court Southern District of Texas. May 15, 2009, Case No. 05–21207, Docket No. 11343.

availability, it plans to consider whatever data are available.

As part of the Agency's evaluation, it plans to examine, at a minimum, the following classes of facilities: hazardous waste generators, hazardous waste recyclers, metal finishers, wood treatment facilities, and chemical manufacturers. This list may be revised as the Agency's evaluation proceeds. EPA is currently scheduled to complete and publish in the **Federal Register** a notice addressing additional classes of facilities the Agency plans to evaluate regarding financial responsibility requirements under CERCLA Section 108(b) by December 2009, and, at that time, will solicit public comment.

VII. Conclusion

Based upon the Agency's analysis and review, it concludes that hardrock mining facilities, as defined in this notice, are those classes of facilities for which EPA should identify and first develop requirements pursuant to CERCLA Section 108(b). EPA will carefully examine specific activities, processes, and/or metals and minerals in order to determine what proposed financial responsibility requirements may be appropriate. As part of this process, EPA will conduct a close examination and review of existing Federal and State authorities, policies, and practices that currently focus on hardrock mining activities.[50]

Dated: July 10, 2009.

Lisa P. Jackson,

Administrator.

[FR Doc. E9–16819 Filed 7–27–09; 8:45 am]

BILLING CODE 6560–50–P

[50] As part of developing proposed and final rules the Agency will consider whether hardrock mining facilities which have a RCRA Part B permit or are subject to interim status under RCRA Subtitle C and already are subject to RCRA financial assurance and facility-wide corrective action requirements need to also be subject to the financial responsibility requirements under Section 108(b) of CERCLA. In addition, EPA is aware and will consider in its development of proposed and final rules, that mining on Federal land triggers either the Bureau of Land Management's (BLM) Part 3809 regulations (43 CFR Part 3809) and the Forest Service's Part 228 regulations (36 CFR Part 228), both have financial responsibility requirements that cover reclamation costs. Many States also have reclamation laws.

ENVIRONMENTAL PROTECTION AGENCY

[FRL–8932–9]

Modification of the 1985 Clean Water Act Section 404(c) Final Determination for Bayou aux Carpes in Jefferson Parish, LA

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice.

SUMMARY: This is a notice of EPA's Modification of the 1985 Clean Water Act Section 404(c) Final Determination for Bayou aux Carpes to allow for the discharge of dredged or fill material for the purpose of the construction of the West Closure Complex as part of the larger flood protection project for the greater New Orleans area. EPA believes that this Final Determination for modification achieves a balance between the national interest in reducing overwhelming flood risks to the people and critical infrastructure of south Louisiana while minimizing any damage to the Bayou aux Carpes CWA Section 404(c) site to the maximum degree possible in order to avoid unacceptable adverse effects.

DATES: *Effective Date:* The effective date of the Final Determination for Modification was May 28, 2009.

ADDRESSES: U.S. Environmental Protection Agency, Office of Water, Wetlands Division, Mail code 4502T, 1200 Pennsylvania Ave, NW., Washington, DC 20460. The following documents used in the Bayou aux Carpes modification are listed on the EPA Wetlands Division Web site at *http://www.epa.gov/owow/wetlands/regs/404c.html:* New Orleans District of the Corps letter dated November 4, 2008, requesting that EPA modify the Bayou aux Carpes CWA Section 404(c) designation; Public Notice of Proposed Determination to modify the Bayou aux Carpes CWA Section 404(c) designation published in the **Federal Register** on January 14, 2009; April 2, 2009, Recommended Determination (RD) for modification of the Bayou aux Carpes 404(c) action; and the May 28, 2009, Modification of the 1985 Clean Water Act Section 404(c) Final Determination for Bayou aux Carpes. Additional documents that are related to the Bayou aux Carpes modification can be located on the U.S. Army Corps of Engineers New Orleans District Web site at *http://www.nolaenvironmental.gov/projects/usace_levee/IER.aspx?IERID=12.*

Publicly available document materials are available either electronically through *http://www.regulations.gov* or in hard copy at the Water Docket, EPA/DC, EPA West, Room 3334, 1301 Constitution Ave., NW., Washington, DC. The Public Reading Room is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is (202) 566–1744, and the telephone number for the Water Docket is (202) 566–2426.

FOR FURTHER INFORMATION CONTACT: Mr. Clay Miller at (202) 566–1365 or by e-mail at *miller.clay@epa.gov.* Additional information and copies of EPA's Final Determination for Modification are available at *http://www.epa.gov/owow/wetlands/regs/404c.html* or *http://www.nolaenvironmental.gov/projects/usace_levee/IER.aspx?IERID=12.*

SUPPLEMENTARY INFORMATION: Section 404(c) of the Clean Water Act (CWA) (33 U.S.C. 1251 *et seq*) authorizes EPA to prohibit, restrict, or deny the specification of any defined area in waters of the United States (including wetlands) as a disposal site for the discharge of dredged or fill material whenever it determines, after notice and opportunity for public hearing, that such discharge into waters of the United States will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas.

Congress directed the U.S. Army Corps of Engineers (Corps) to enhance the existing Lake Pontchartrain and Vicinity Hurricane Protection project and the West Bank and Vicinity Hurricane Protection project to the 100-year level of protection. One section of this much larger project is within the Bayou aux Carpes area that is subject to a 1985 EPA CWA Section 404(c) action that prohibited the discharge of dredged or fill material in the Bayou aux Carpes site south of the New Orleans metro area. On November 4, 2008, the New Orleans District of the Corps requested a modification of the Bayou aux Carpes CWA Section 404(c) designation to accommodate discharges to the Bayou aux Carpes wetlands associated with the proposed enhanced levee system in Jefferson Parish, Louisiana.

In evaluating the Corps of Engineers proposal for modification of the 1985 Bayou aux Carpes CWA Section 404(c) Final Determination, the key elements of a Section 404(c) process were followed. These include a hearing and opportunity for the public to provide written comments, preparation and submittal of a Recommended Determination proposed by EPA Region 6 to EPA Headquarters, and a Final Determination for Modification issued by EPA Headquarters.

Background

On October 16, 1985, EPA issued a Final Determination pursuant to Section 404(c) of the Clean Water Act restricting the discharge of dredged or fill material in the Bayou aux Carpes site, Jefferson Parish, Louisiana, based on findings that the discharges of dredged or fill material into that site would have unacceptable

BARAGA BASIN

Overview

In the Baraga Basin Project Area Prime Meridian has mineral land tenure on seven targets prospective for magmatic nickel-copper deposits associated with the Midcontinent Rift System (MRS). Three of these are drill-ready, and three of these are within a four kilometre radius of Rio Tinto's Eagle deposit, discovered in 2002. Rio Tinto has announced that Eagle contains a reserve of 5.2 million tons at a grade of 3.68% nickel, 3.06% copper, 0.1% cobalt, with platinum group and gold values. As of January 2008, Rio Tinto has received all permits needed to begin construction and mining this deposit.

Prime Meridian's current targets were defined by electromagnetic, magnetic and gravity surveys. The company plans to begin drill testing these targets beginning in early 2008. Each target has the potential to deliver a significant discovery based on geological and geophysical similarities of its targets with the example nickel-copper deposit nearby at Eagle.

Project description, location and land tenure

This Project Area is located within a 760 square kilometre region of Baraga and Marquette Counties in northern Michigan. The favorability of this part of the MRS terrane is clearly evidenced by the existence of the Eagle deposit within it. Prime Meridian is in direct competition here with Rio Tinto's subsidiary, Kennecott Exploration Company. Prime Meridian's land position at the Baraga Basin Project, totaling slightly over 4,000 mineral hectares, is the largest in the company's portfolio. Its lands are held principally by a number of 100% mineral interest leases, and in a few cases, by outright purchases of fractional mineral rights interests from various owners.

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Area Infrastructure

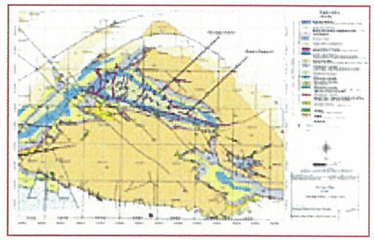
This Project Area is located in a sparsely populated section of Baraga and Marquette Counties in the upper peninsula of Michigan. There are no paved roads within the Project Area itself, but U. S. Highway 41/28 borders its southern and western margins and provides access via a network of unpaved logging roads. The nearest towns are L'Anse, population 2107, located on Keweenaw Bay in the western part of the Project Area, and Big Bay, population 260, located 6 miles east of the Project Area. The nearest substantial population centre is Marquette, a port city located approximately 40 road kilometres to the southeast on the shore of Lake Superior. Marquette has approximately 30,000 residents, and has been a major industrial centre for the iron mining industry for over 100 years.

Geology

Regional Geology

Project Geology

"Baraga Basin" is an informal name that refers to a structural trough filled by Proterozoic Michigamme Formation metasediments of the Marquette Range Supergroup. Because of thick Pleistocene glacial sediment cover in the basin, there are few surface exposures of the Michigamme Formation rocks, which in outcrop are mostly black slate (often sulfide-bearing) and argillite. However, drill core obtained by the Michigan Department of Natural Resources along the southern flank of the basin indicate that conglomerate, quartzite and arkose underlie the black slate and argillite. All of these are regionally metamorphosed to greenschist facies.


Baraga Basin Geology

Younger Keweenawan-age mafic igneous bodies intrude the Michigamme Formation. The Yellow Dog peridotite dike is the best known of these intrusions because of two outcrops that were studied by the U. S. Geological Survey (USGS) in 1979, and because the Yellow Dog peridotite is the host rock for the Eagle deposit. Its two outcrops correspond with the highest peaks of an east-west aeromagnetic anomaly that is approximately 22 kilometres long. Linear aeromagnetic anomalies of comparable magnitude parallel it just to the south; however, past drilling by Prime Meridian suggests that these other magnetic highs represent pyrrhotitic metasediments rather than intrusions.

Structural geology has been primarily interpreted from regional magnetic surveys. Northwest striking features cross-cut and horizontally displace the general west-northwest strike of the metasedimentary stratigraphy. These are cut and horizontally displaced by younger northeast-striking structures. The northeast faults also displace the Yellow Dog dike and are therefore late or post-Keweenawan in age.

History

The 1979 USGS report focused on the geology, petrology and geochemistry of the Yellow Dog intrusion. Ground geophysical surveys that included gravity, magnetics and VLF-EM were done along the postulated 22 kilometre east-west extent of the intrusion. Based on its anomalous base metal geochemistry and positive EM anomalies, the USGS report concluded that the Yellow Dog peridotite was a potential host for nickel-copper mineralization.

Kennecott recognized this potential and began an exploration program in the 1990's, focused on the Yellow Dog peridotite. In 2002, in the first hole of a second round of drilling, Kennecott intersected 84.2 meters of massive sulfide mineralization averaging 6.3% nickel and 4.0% copper. The top of the orebody that Kennecott eventually outlined by subsequent intensive drilling lies some 100 meters below the outcrop. In February 2006, Kennecott began submission of applications for mining permits; it received the last of the needed permits in January, 2008.

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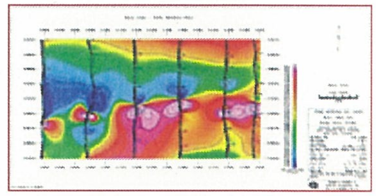
Prime Meridian's Exploration Program

In 2002 Prime Meridian conducted geological reconnaissance mapping and sampling on mineral lease areas in the Baraga Basin, and entered into a joint venture with BHP-Billiton Minerals Exploration Inc. (BHPB) to explore for magmatic intrusion-hosted nickel-copper deposits in the Baraga Basin, Bangston and Kiernan Sills Project Areas. In 2003 the joint venture partners flew electromagnetic and magnetic surveys over the joint venture areas. Drill testing was needed to evaluate and understand the survey results. Seven targets were drilled in 2003 without significant results, which established the need for additional geophysical techniques to identify and prioritize targets. In 2004 an airborne gravity survey using BHPB's proprietary Falcon system was flown over the eastern portion of the Baraga Basin Project Area. Additional surveys were flown in mid-2005, but their results did not become available until after the joint venture was terminated that year. Meantime, in late 2004, three more Prime Meridian targets were


2007 Heliborne Survey - Baraga Basin


Baraga Basin drilling (2004)

drill tested. At two of them, the core drilling successfully intersected olivine gabbro intrusive rock types. Unfortunately, economic mineralization was not found in either of these mafic bedrock bodies.



Baraga Basin, example of drill target with magnetic high and coincident conductors

Current Plans

The airborne surveys, taken together with the 2003-4 drill testing results which assisted in interpreting the geophysical responses, identified a number of new high priority targets on Prime Meridian's mineral lands. The company did confirmation ground geophysical surveying on two of these.

PMR has additional high priority targets that exhibit magnetic anomalies, in combination with one or both of gravity/EM anomalies on trend with the Eagle Deposit.

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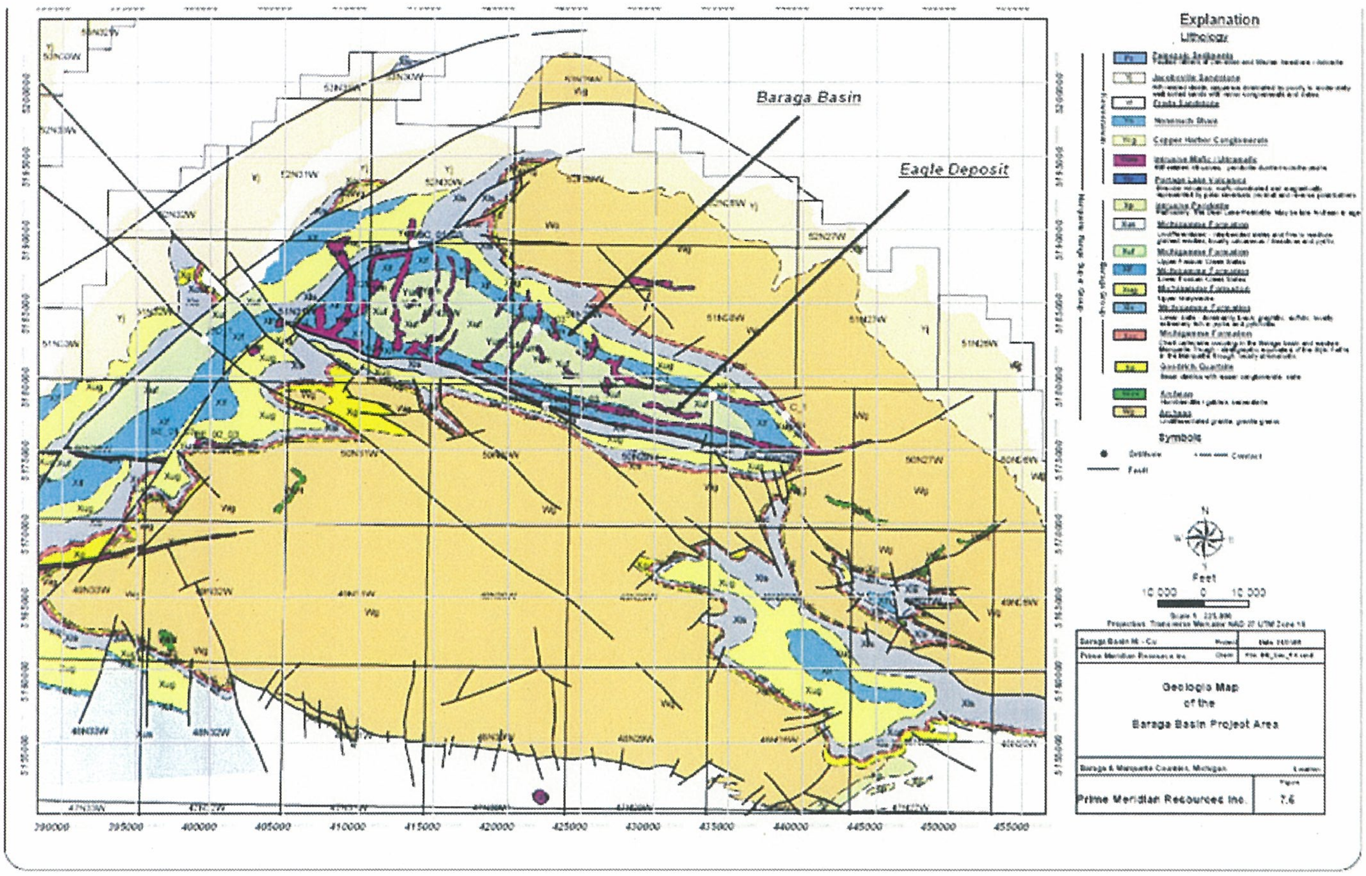
Baraga Basin
Eagle Deposit
Explanation
Lithology
Copper Harbor Conglomerate
Goodrich Quartzite
Symbols
Feet
Geologic Map
of the
Baraga Basin Project Area
Prime Meridian Resources Inc.
7.6

Bitterroot Resources Ltd.

Upper Peninsula, Michigan (Nickel-Copper)
Bitterroot owns 363 square miles of mineral rights in Michigan's Upper Peninsula, mainly in Ontonagon, Houghton, Baraga, and Iron Counties. The lands are subdivided into two general packages - the Voyageur Lands (257 square miles) and the Copper Range Lands (106 square miles). Bitterroot also holds mineral leases and prospecting permits covering 4,500 acres. Through its wholly-owned subsidiary, Trans Superior Resources, Inc., Bitterroot is one of the largest holders of mineral rights in the Upper Peninsula.

The Copper Range land package covers a portion of the famous Keweenawan copper district, which produced more than eight million tonnes of copper between 1845 and 1995. Bitterroot's Copper Range Lands have been subjected to limited exploration drilling since the 1960s. There are more than 100 past-producing copper mines, pits, and prospects located within or adjacent to this land package. In 2010, Bitterroot's ground-based and airborne geophysical surveys (AeroTEM) and geological mapping defined several drill targets prospective for copper and nickel. The Company has recently acquired additional leases and prospecting permits covering 2,300 acres (930 hectares) of mineral rights and is in discussions with potential joint venture partners, with the objective of drill-testing these targets later this year.

The Voyageur lands cover a diverse assemblage of Proterozoic sedimentary and volcanic rocks and have the potential to host a variety of minerals, including nickel, copper, platinum group metals and gold. Despite the extensive history of copper and iron mining in the western Upper Peninsula, the Voyageur Lands are at a relatively early stage of exploration. Within the Voyageur lands, Bitterroot has identified significant potential for platinum group metals (PGM) mineralization in the 35 square-kilometre footprint of the Echo Lake layered mafic intrusion. In 1997, Bitterroot drilled 3,270 meters (10,728 feet) in five core holes at Echo Lake. Drill hole EL-97-03 intersected ten flat-lying anomalous PGM-bearing horizons within the intrusion, with the highest-grade interval containing 1.01 grams Pt+Pd+Au/tonne over 5.42 metres (17.8 feet), within a 21.3 metre (69.8 feet) interval grading 0.52 grams Pt+Pd+Au/tonne. The Echo Lake intrusion has potential to host additional reef-type PGE mineralization along strike from the currently known mineralized zones and Ni-Cu-PGE mineralization along its contacts or within satellite intrusions and feeder dykes.

More Information
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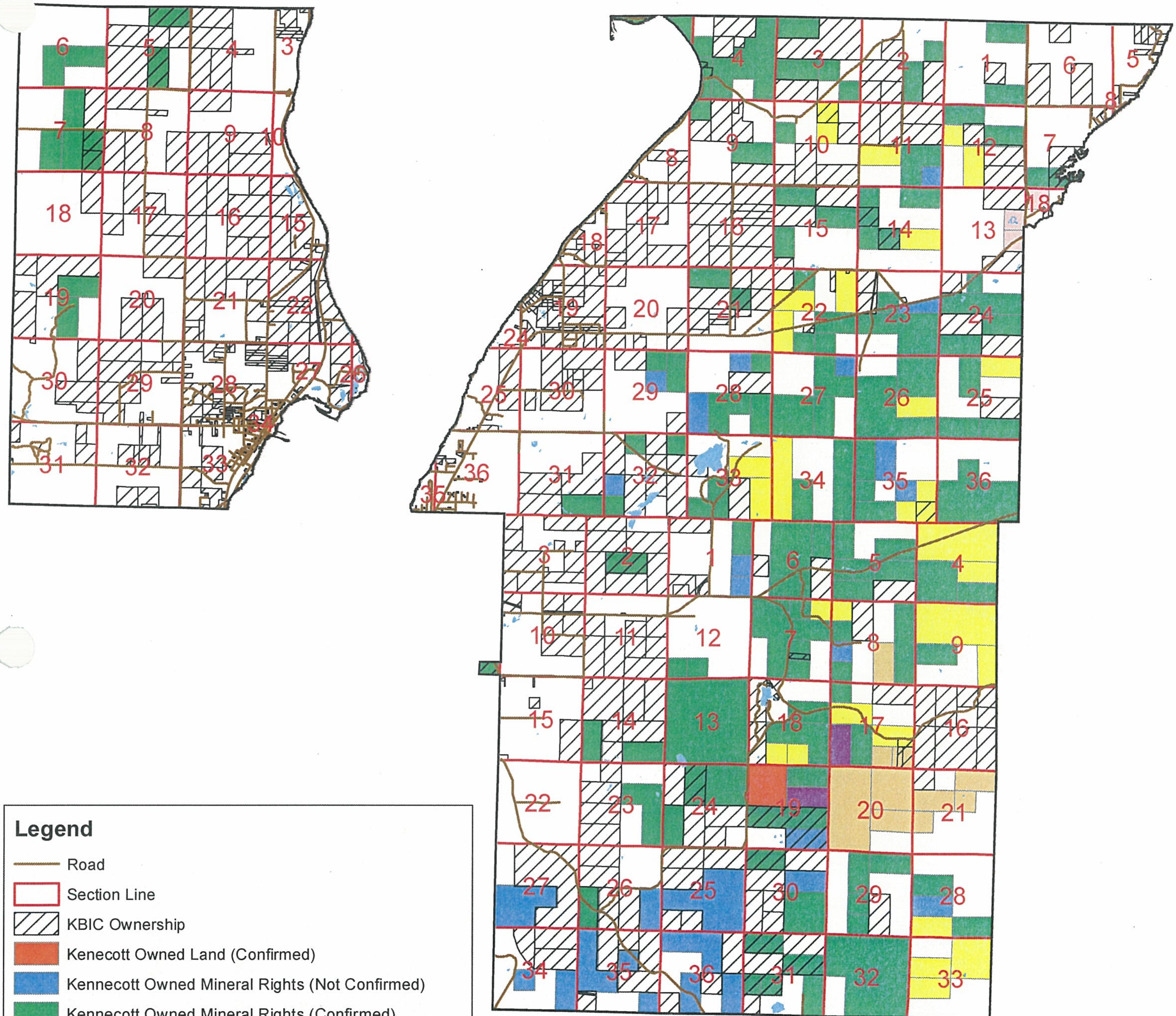

Legend

- Road
- Section Line
- KBIC Ownership
- Kenecott Owned Land (Confirmed)
- Kennecott Owned Mineral Rights (Not Confirmed)
- Kennecott Owned Mineral Rights (Confirmed)
- Kennecott leased Mineral Rights (Not Confirmed)
- Beefsteak Owned Mineral Rights (Not Confirmed)
- Prime Meridian Owned Mineral Rights (Not Confirmed)
- Prime Meridian Leased Mineral Rights (Not Confirmed)

Source: Save the UP, KBIC, Baraga County

Note: Mineral data was created by the Save the U.P. KBIC's Realty/GIS office has found errors in the data and the integrity of the data is in question. Some data has been confirmed through research at Baraga County Registry of Deeds and indicated in the legend.

Mineral Rights
KBIC's Reservation

N

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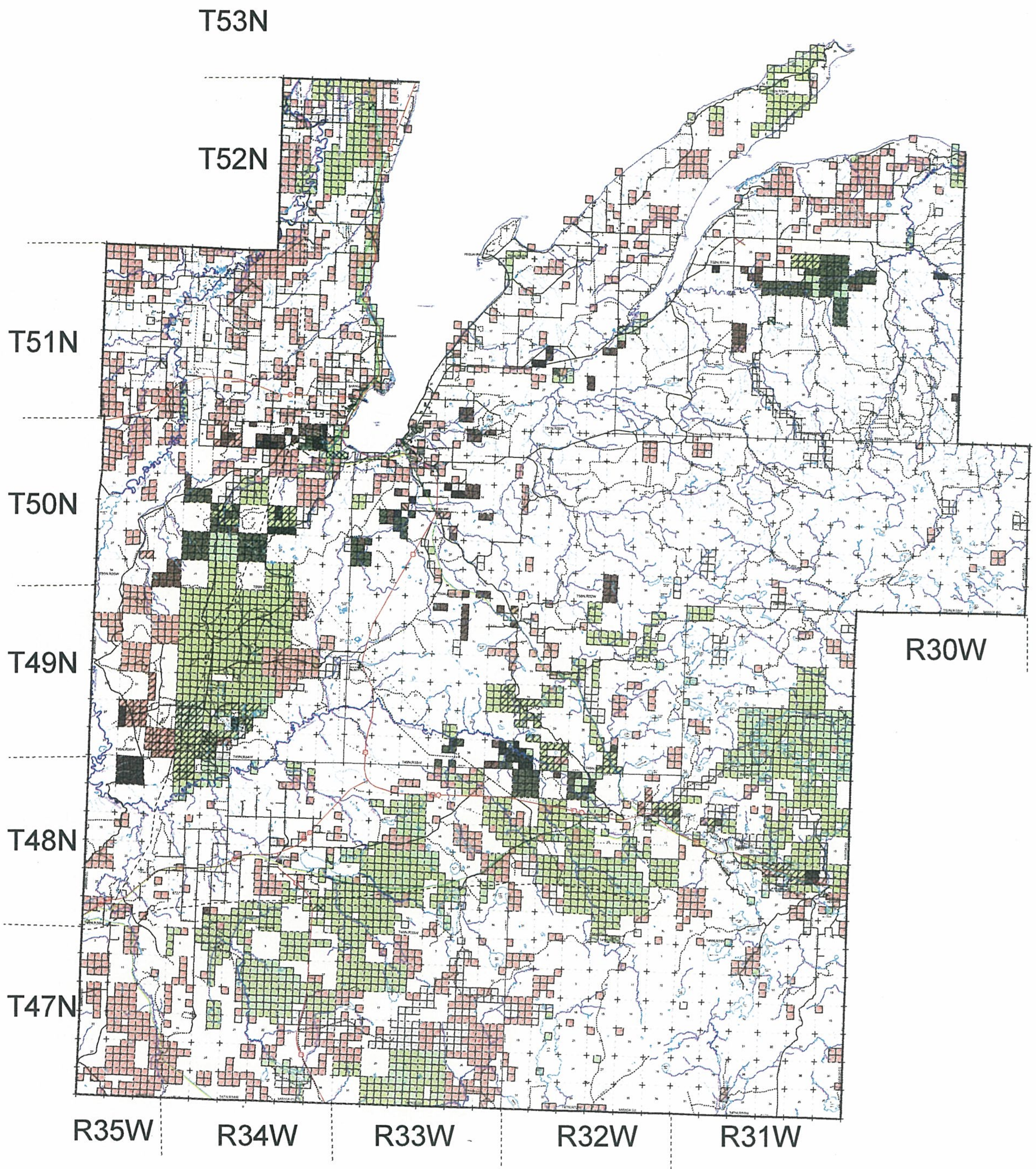
Miles

MINERAL LEASE [illegible]ORMATION, AND DNR OW[illegible]ERSHIP

Baraga County



LEGEND

LEASE CLASSIFICATION RECOMMENDATION
- Development
- Development with Restrictions
- Non-Development
- Non-Leasable
- Mixed Classification

LEASE NUMBER
- 12345 Development Lease
- R12345 Development with Restrictions Lease
- N12345 Non-Development Lease
- S12345 Gas Storage Lease
- M12345 Metallic Mineral Lease
- Z12345 Nonmetallic Mineral Lease
- * Multiple Leases within QQS - one lease # shown

DNR OWNERSHIP
- Surface
- Mineral and Surface
- Minerals
- Mixed Ownership
- Other Rights
- R Reserved Minerals
- 40.00 Acres of Surface Ownership
- 40.00 Acres of Mineral and Surface Ownership
- 40.00 Acres of Mineral Ownership
- ROW DNR has a Right of Way and/or an acquired easement(s) from private landowner within the quarter-quarter section

TRANSPORTATION
- Two-Track and Seasonal Roads
- Highways
- Residential Roads
- Railroads
- Paved Airports
- Unpaved Airports
- County Roads

UTILITY
- Pipelines and Transmission Lines
- Electric Transmission Lines

POLITICAL
- Township Boundaries
- Great Lakes Shoreline
- County Boundary
- Section Lines

HYDROLOGY
- Lakes and Ponds
- Rivers and Streams
- Drains and Intermittent Streams

0 1 2 3 4 Miles

N

MAP INFORMATION

Lease classification recommendations are current and may differ from lease type (i.e., the lease was issued prior to the most current review).

Classification designations on individual parcels are reviewed each time lands are offered for lease. Parcels may be offered for lease under different classifications at future sales.

Mineral Lease and DNR Land Ownership information is derived weekly from the MDNR's Land Ownership Database. Parcel information is compiled to the quarter-quarter section level. Multiple parcels with varying types of ownership within a quarter-quarter section result in the Mixed Ownership Category. Non-ownership rights are classified as Other Rights.

COMPLETENESS and QUALITY
In general, the data does not reflect platted parcels, Private Claims, and parcels within the City of Detroit and/or Saint Clair County Flats.

The amount of acreage owned within a quarter-quarter section is identified by acreage labels in the upper-right corner of each quarter-quarter section.

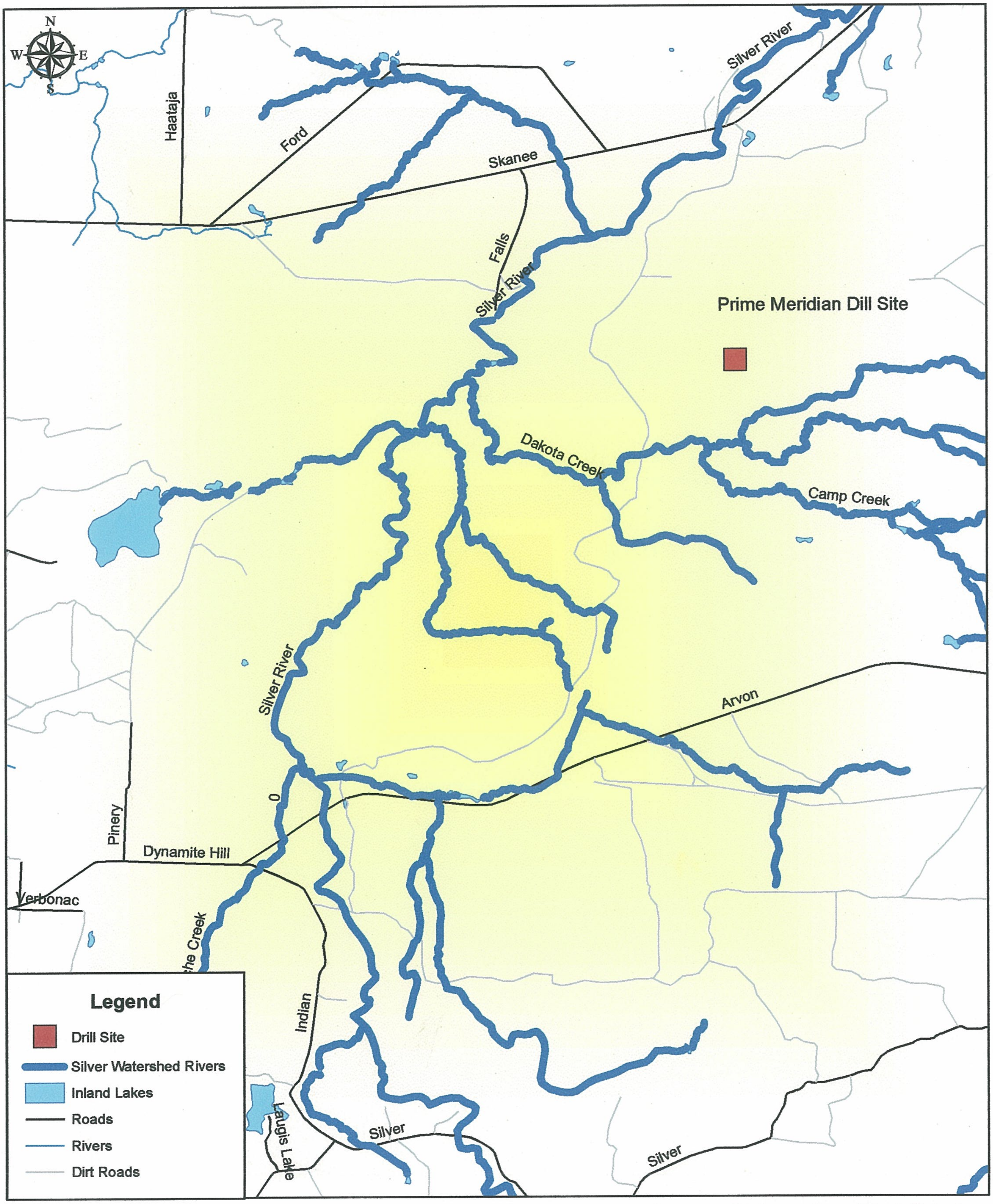
The quality and completeness of this data is unknown. It is suggested that this data be combined with a second source, such as plat maps, to further identify ownership.

The information displayed on this map is intended for general planning purposes only. Specific ownership [illegible]

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
Forest, Mineral and Fire Management

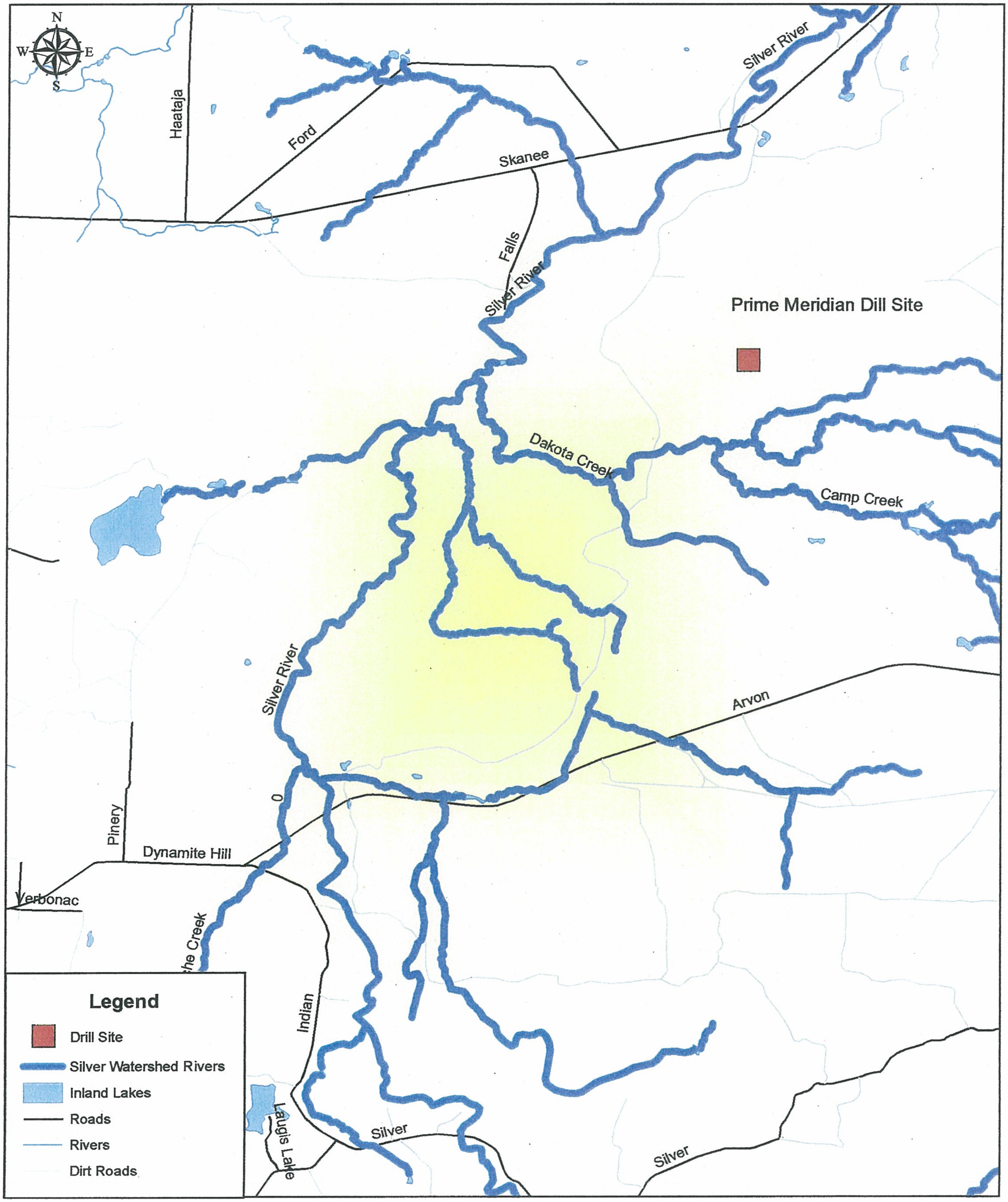
DATE 11/15/2011

Keweenaw Bay Indian Community
Prime Meridian Drill Site



Cartographer: Micah Petoskey

Keweenaw Bay Indian Community
Prime Meridian Drill Site



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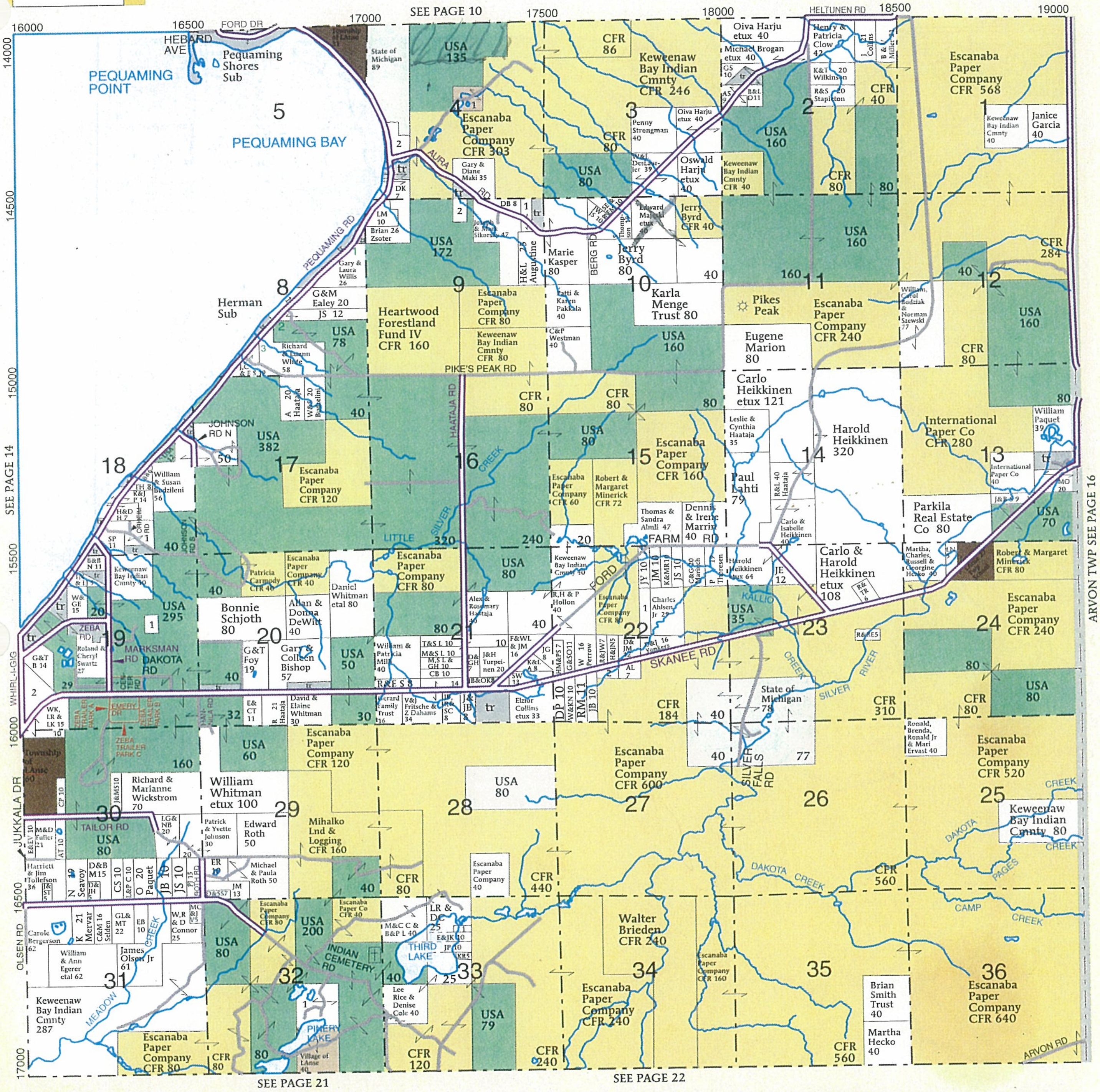
See Page 63 For Additional Names.

BARAGA COUNTY



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Field Trip 7

GEOLOGY OF THE KEWEENAWAN BIC INTRUSION

Dean Rossell

Kennecott Minerals Company

Petrology and Cu-Ni-PGE mineralization of the Bovine Igneous Complex, Baraga County, Northern Michigan

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The Bovine Igneous Complex (BIC), located 8 km southeast of the town of L'Anse, Michigan, is a small basin-shaped mafic/ultramafic intrusion emplaced in the southwestern part of the Baraga Basin. Although age dating of the intrusion has so far been unsuccessful, the BIC intrusion was very likely emplaced during the early magmatic stage of Midcontinent Rift development, given its similarities to other early stage intrusions, such as Tamarack (MN) and Eagle (MI).

Investigated by Kennecott as a possible Cu-Ni-PGE prospect, the intrusion has undergone extensive exploration drilling since 1995. This work has shown the intrusion to be weakly to moderately mineralized with Cu-Ni-PGE-enriched sulfides. Metal tenors provided by initial drilling averaged less than .5% Cu and Ni, and less than 350 ppb Pt and Pd (Rossell, 2008). For this study, which is part of Dan Foley's MS thesis, two drill cores that profile the BIC (08BIC044 and BIC01-01) were investigated for their petrographic attributes, cryptic mineral compositions, and whole rock geochemistry. A detailed (1:6,000) re-mapping of the BIC was also conducted for this study.

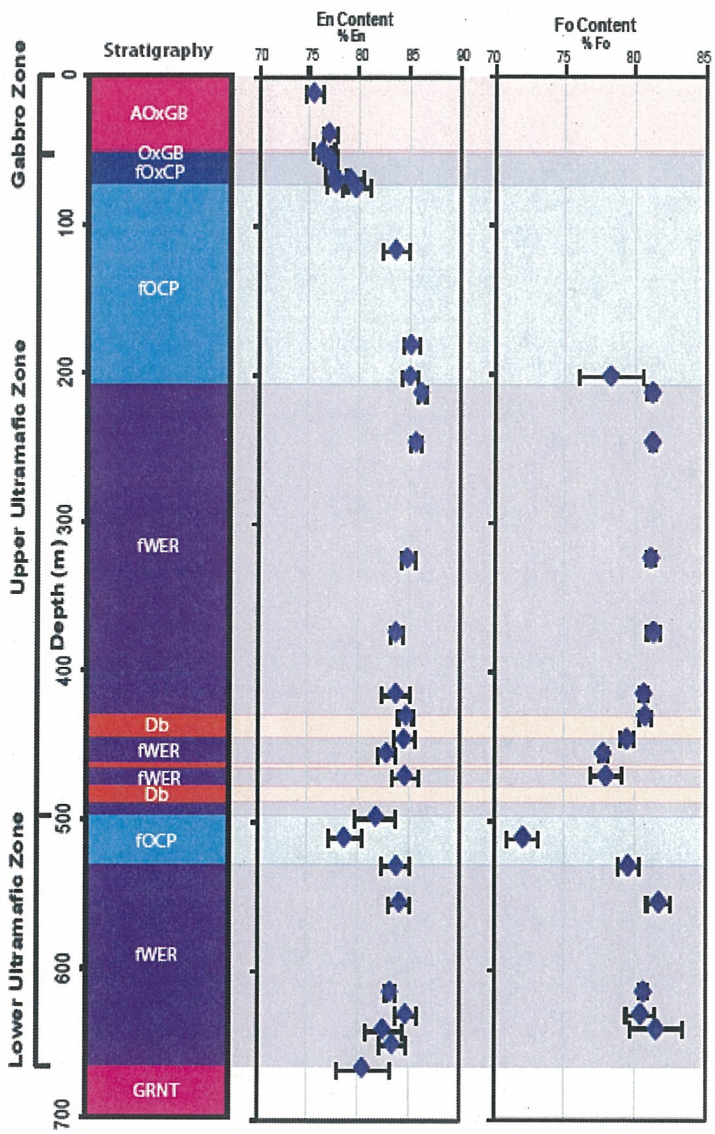
Preliminary field and petrographic studies by Rossell (2008) interpreted the intrusion to be a simple three unit system composed of a basal wehrlite/melagabbro, overlain by a clinopyroxenite/gabbro, and finally an oxide gabbro. Field mapping, core logging, and petrography conducted for this study have found that the lithostratigraphy of the BIC is a somewhat more complicated. The stratigraphy can be subdivided into three main zones – a lower ultramafic zone, an upper ultramafic zone, and a gabbro zone, each of which can be further subdivided by cumulate mineralogy. As profiled in core 08BIC044 (Fig. 1), the lower ultramafic zone is in sharp contact with a footwall of granitic gneiss at about 670m. A medium fine-grained feldspathic wehrlite (Ol cumulate with intercumulus Cpx and Pl) occurs at the basal contact and gradually coarsens up section and becomes less feldspathic. At about 525m, augite abruptly increases in mode and becomes granular to create a feldspathic olivine pyroxenite (Cpx+Ol cumulate with intercumulus Pl). The contact with the base of the upper ultramafic zone, at about 500m, is marked by the abrupt reappearance of feldspathic wehrlite that is vari-textured and contains abundant inclusions of chert and carbonate. Several fine-grained mafic dikes cut the lower 70 meters of this heterogeneous wehrlite. Above the uppermost dike, a more homogeneous, medium-grained feldspathic wehrlite (Ol cumulate with intercumulus Cpx and Pl) persists up to about 205m, at which point cumulus augite reappears and the modal rock type becomes a feldspathic olivine clinopyroxenite (Cpx+Ol cumulate with intercumulus Pl). At about 75m, an abrupt increase in the Fe-Ti oxide mode to about 10% and a loss of olivine generates a feldspathic oxide clinopyroxenite (Cpx+Ox±Ol cumulate with intercumulus Pl). Soon thereafter (~ 60m), plagioclase becomes abundant (>50%) and lath-shaped to create an oxide gabbro (Pl+Cpx+Ox cumulate). Apatite becomes a cumulus phase at about 50m to create an uppermost cumulate of Pl+Cpx+Ox+Ap. Outcrops of apatitic oxide gabbro, at presumably higher stratigraphic levels than seen in drill core, contain patches of interstitial granophyre. Assuming upward-directed crystallization, this igneous stratigraphy implies a cumulus paragenesis of:

Ol→ Cpx+Ol // Ol→ Cpx+Ol→Cpx+Ox±Ol →Pl+Cpx+Ox→Pl+Cpx+Ox+Ap.

The cumulus regression evident at the lower and upper ultramafic zone contact and the heterogeneous nature of the basal upper ultramafic zone strongly implies that this contact demarks two major magma emplacement events.

Further evidence of two episodes of magma emplacement come from mineral chemical data on olivine and augite. Cryptic variations of Fo and En components through core 08BIC044

(Fig. 1) show trends that are consistent with two major episodes of emplacement followed by fractional crystallization. The base of each ultramafic zone is characterized by decreased En content of postcumulus augite which is consistent with chilling of a parental magma. Fo content of olivine in the lower ultramafic zone remains elevated, which is consistent with chilling of primocrystic olivine. Olivine at the base of the upper ultramafic zone shows a decrease in Fo suggesting reequilibration of a new magma pulse with the resident magma. As both the lower and upper ultramafic zone wehrlites transition into olivine clinopyroxenites, both Fo and En decrease, which is consistent with progressive iron enrichment due to fractional crystallization. Interestingly, the upper ultramafic zone and overlying gabbro zone progress to more evolved cumulates, but the cryptic variation is more muted than in the lower ultramafic zone. Noting that the upper ultramafic cumulates are more adcumulate (i.e. contain less postcumulus minerals) than the lower ultramafic zone cumulates, the more subdued cryptic variation of the upper cumulates may be due to a lower trapped liquid shift.



A suite of 27 samples have been submitted for lithogeochemical and assay analyses, but the results were not available at the time of this writing. We hope to report on the geochemical data at the meeting. The whole rock geochemistry will be used to evaluate whether the two magma pulses involved similar parental magma composition. Analyses of wehrlite from the base of the lower ultramafic zone and mafic dikes from the base of the upper ultramafic zone will be evaluated as potential candidates for chilled parent magma compositions. The geochemical data will also be used to evaluate the history of sulfide saturation and metallogenesis during the crystallization of the BIC magma(s).

Figure 1. Lithostratigraphy and cryptic variation of Fo in olivine and En in augite in DDH 08BIC044. Unit abbreviations are fWER-feldspathic wehrlite, fOCP-feldspathic olivine clinopyroxenite, Db-diabase, fOxCP – feldspathic oxide clinopyroxenite, OxGB – oxide gabbro, AOxGB – apatitic oxide gabbro

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The Geology and Geologic Setting of the BIC Cu-Ni-PGE Prospect, Baraga County, Michigan U.S.A.

Introduction

The BIC mafic/ultramafic intrusion is located in Baraga County, Michigan, approximately 8 km southeast of the town of L'anse, Michigan. The roughly 1.1 km by 0.4 km, oval shaped intrusion forms a prominent hill with good exposures of the principle units that comprise the intrusion. The BIC intrusion has not been dated yet. However, based primarily on compositional similarities, Kennecott geologists believe it is similar in age to the mafic/ultramafic intrusion that hosts the Eagle Cu-Ni-PGE deposit, located ~35km to the east (fig 1), which has been recently dated at 1107.2+/- 5.7ma (Ding, 2007)

The BIC intrusion has been the target of periodic exploration by Kennecott Exploration Company since the first discovery of Cu-Ni-PGE mineralized boulders near the intrusion in the mid-1990's. The first drill hole into the intrusion, in 1995, was positioned at the south edge of the intrusion. The hole (BIC95-1, fig. 3) intersected ~3 m of disseminated sulfide mineralization in olivine melagabbro at the base of the intrusion, averaging 0.43%Cu, 0.32%Ni, 0.325ppm Pt and 0.345ppm Pd.

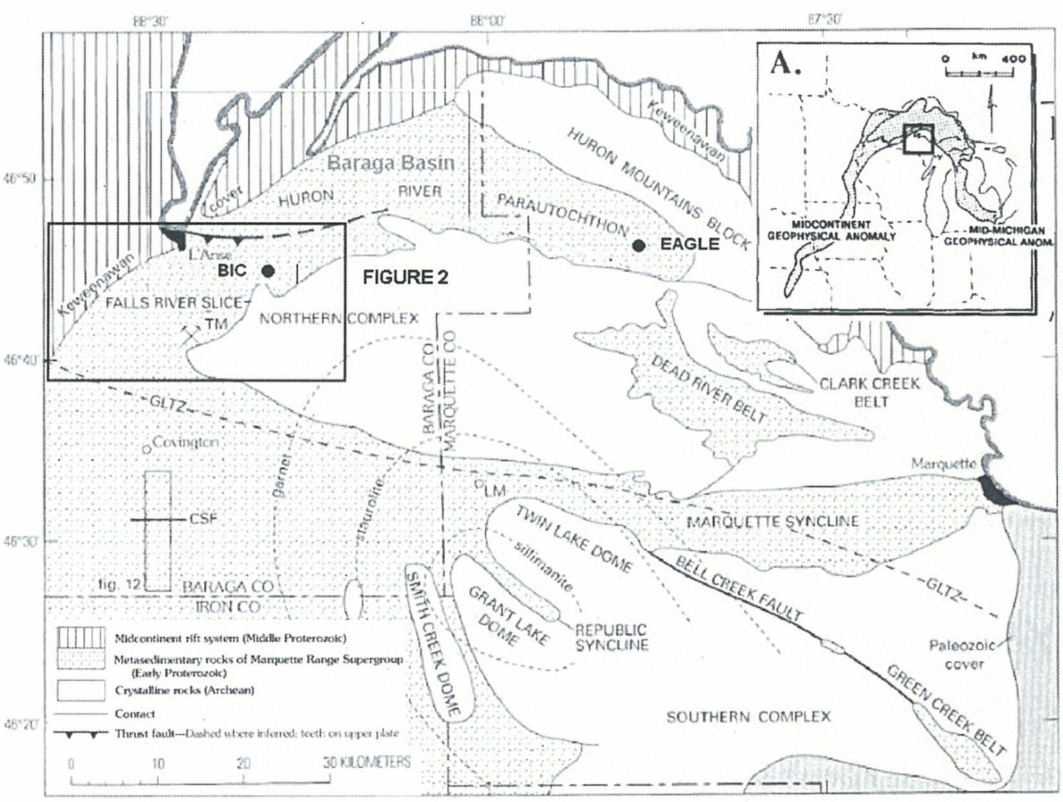

Figure 1) Geology map of the northern portion of the Upper Peninsula of Michigan showing the location of the Baraga Basin and the BIC intrusion. Modified from Gregg (1993)

No significant Cu-Ni-PGE resource has been identified at the BIC prospect yet. However, a drill hole completed by Kennecott Minerals Company in 2006 (07BIC-007), intersected 16.47m averaging 0.88%Cu, 1.00%Ni, 0.679ppm Pt, 0.991ppm Pd and 0.104ppm Au . This interval included a 2.8m interval with bands of massive sulfide, located in the meta-sediments immediately below the base of the intrusion, which averaged 1.66%Cu, 4.23%Ni, 1.383ppm Pt and 2.521ppm Pd. The metal tenor of the massive sulfide bands is comparable to some of the massive sulfides in the Eagle deposit. This could suggest that there is still some potential for a high grade massive sulfide body in the less explored portions of the BIC intrusion.

Previous Geologic Studies

No detailed geology map covers the area immediately around the BIC intrusion. The geology shown in Figure 2 is, in part, modified from data included in the USGS 1:62,500 scale open file geology map of the Precambrian geology of the Dead River, Clark Creek and Baraga Basins (Cannon, 1977). The area in figure 2 is also covered by the Iron River 1° x 2° quadrangle (Cannon, 1986). Geology in the Taylor Mine area (fig. 2) is compiled and modified from detailed mapping by Klasner (1972) and Klasner and others (1991).

Ojakangas (1991) discussed stratigraphic correlations of Paleoproterozoic rocks in the area shown in figure 2. Gregg (1991) and Klasner and others (1991) described Penokean age deformation in the same area. The Archean geology to the southeast of the BIC intrusion is described in an unpublished master's thesis by Turner (1979). A review of the Paleoproterozoic stratigraphy in the Baraga Basin, including the Taylor mine area, was recently undertaken by Gabe Nelson as part of a Masters thesis at Acadia University under Pier Pufal.

The above data sources were supplemented by periodic reconnaissance mapping by me during the period 1999-1996. This work was augmented by regional geophysical studies and drilling programs carried out by personnel of Kennecott Exploration Company, Kennecott Minerals Company and various contractors. The more detailed geologic data from the BIC area is compiled from work by me, other Kennecott Exploration and Kennecott Minerals geologists, contract geologists and reports on petrography completed for Kennecott by Barnett (1995), Hauck (2001) and Johnson (2007).

Regional Setting

The BIC intrusion cuts Paleoproterozoic sediments in the southwestern portion of the Baraga Paleoproterozoic sedimentary basin (fig 1). The Baraga basin is bounded to the north and south, and underlain by Archean crystalline rocks. The Baraga basin merges with the Paleoproterozoic sediments of the Marquette Syncline southwest of the BIC intrusion (fig 1). The Archean, Paleoproterozoic and Mesoproterozoic geology is briefly summarized below.

Archean

The Archean terrane to the immediate south of the BIC intrusion (fig.2) is comprised largely of coarse grained, felsic gneiss and lesser amphibolite intruded by a variety of small mafic to ultramafic intrusions. Although there has been little mapping to confirm it, the gneissic rocks are most likely a continuation of the gneiss, intrusions and lower metamorphic grade supracrustal rocks (Marquette Greenstone Belt) that collectively comprise the Northern Complex (fig 1) to the east. A tonalitic intrusion dated at 2703 Ma and a rhyolite dated at 2780 Ma (Sims, 1993), are the only available age dates from the Northern Complex.

Paleoproterozoic

The recent discovery of the Sudbury ejecta horizon in the Baraga Basin (see below) constrains the bulk of Paleoproterozoic sedimentation to post 1850ma. Gregg (1993) divided the Baraga basin into two principle structural domains; the northern Huron River parautochthon and the southern allochthonous Falls River slice. Gregg proposed the boundary between the terrranes, which is marked by an abrupt change in structural style, is a south dipping thrust fault that he named the Falls River Thrust (fig. 2).

Paleoproterozoic sediments to the north of the Falls River Thrust are characterized by weakly asymmetrical, relatively open folds with shallow axial plunges to the northwest or southeast. A single, southwest dipping, axial planar foliation is evident in most pelitic and siltstone horizons. Immediately south of the Falls River Thrust, folds are tight to isoclinal, generally overturned and often recumbent. In the Falls River slice, larger scale folds are overprinted by a second generation of folds with an associated crenulating foliation that is particularly evident in pelitic sediments. Boudinaged and folded quartz veins and lenses are prevalent in coarser-grained meta-greywacke beds in the Falls River slice.

Klasner and others (1991) mapped a thrust fault in the Komtie Lake area, south of the BIC intusion (fig. 2). They reported that a vertical exploration drill hole, located on the south side of Komtie Lake, penetrated 30 m of Archean gneiss followed by 3 m of mylonite before intersecting 45 m of Paleoproterozoic sediments. They proposed an approximately east-west striking and south dipping thrust fault that brought Archean gneiss over a thin veneer of the basal Paleoproterozoic sediments. They extended the fault westward to include strongly foliated rocks exposed along Plumbago Creek (fig 2). I extended the Komtie Lake thrust fault further to the northeast in figure 2, to an area where magnetic anomalies originating in the Paleoproterozoic sediments appear to continue under exposures of Archean gneiss. This extension has not been confirmed by mapping.

Exposures of pelitic rocks in the immediate area of the Taylor mine (stop 3, fig. 2) generally lack the prominent crenulating cleavage seen in pelitic rocks exposed all along Taylor Creek further to the north (stop 4, fig. 2). Drill hole T-5, a 68.5 m deep vertical exploration hole collared northeast of the Taylor mine pit (fig. 2), bottomed in mylonitic rock. I propose that there is another generally east-west striking thrust fault north of drill hole T-5, separating the overriding Taylor Mine slice from the more deformed rocks of the Falls River Slice. Alternatively, the fault could be the westward continuation of the Komtie Lake thrust fault.

Historically, deformation of the Paleoproterozoic sediments in the western portion of the Upper Peninsula has been attributed to a series of collisional events between 1888 Ma and 1830 Ma that collectively make up the Penokean orogeny (Schultz and Cannon, 2007). However, Schultz and Cannon (2007) point out that there is evidence of vertical faulting and uplift that significantly post date1830 Ma. They concluded that this younger deformation cannot be attributed to the Penokean orogeny and that it is more likely of Yavapai age.

Mesoproterozoic

Mesoproterozoic flood basalts associated with the Keweenaw Flood basalt Province are exposed along the length of the Keweenaw Peninsula and 30km southwest of the BIC intrusion at Silver Mountain, Michigan. The Keweenaw Flood Basalt province represents the exposed portion of the Midcontinent Rift system in the Lake Superior region. The Midcontinent Rift forms a prominent gravity anomaly that can be traced from the Lake Superior region southwest into central Kansas, and southeastward into southern Michigan. The total length of the geophysical feature is in excess of 2000 km (Hinze and others, 1997). Seismic data indicates the rift below Lake Superior is filled with more than 25km of volcanics buried beneath a total thickness of up to 8km of rift filling sediments (Bornhorst and others, 1994). The estimated volume of magmatic rocks associated with the rift is greater than 2 million cubic kilometers (Cannon, 1992).

The Keweenaw Flood Basalt province was formed over an approximately 23 million year period, from ~1111 Ma. to ~1089 Ma. Volcanism was bimodal, but with preserved basaltic rocks much more abundant than rhyolitic rocks. Volcanism occurred in two distinct phases, with an approximately 5 million-year hiatus between phases (Miller, 1996). In Michigan and Wisconsin, the early phase volcanics are comprised of the Sieman's Creek formation and volcanics of the Powdermill group (Wiband and Wasuwanich, 1980). The Portage Lake volcanics comprise the younger phase. The early phase volcanics are primarily reversely polarized. The Portage Lake volcanics are normally polarized. A mantle plume model has been widely evoked to explain the staged evolution and large volume of magmatic products associated with the Midcontinent Rift (Nicholson, 1997).

Red bed sandstones (Jacobsville Sandstone) shed off the horst block formed during inversion of the Midcontinent Rift, cover Paleoproterozoic sediments west of BIC (fig. 2). Rift inversion may have begun as early as 1080 Ma and was completed by about 1040 Ma (Cannon, 1994). The probable cause of compression was continental collision in the Grenville province (Cannon, 1994).

Paleoproterozoic Stratigraphy

Archean rocks are either unconformably overlain by, or in fault contact with, Paleoproterozoic meta-sediments along the southern margin of the Baraga Basin. Ojakangas (1994) has correlated sediments in the Baraga Basin and western Marquette trough with the Baraga Group, the youngest of the three dominantly clastic sedimentary groups that comprise the Marquette Range Supergroup. He concluded, on the basis of paleocurrents, paleogeographic setting and isotopic data that the best tectonic model for Baraga Group sedimentation is a northward migrating foreland basin.

Quartzites at the base of the Paleoproterozoic sedimentary sequence in the Baraga basin north of the Falls River thrust and in the Canyon Falls area (stop 1-fig. 2) are correlated with the Goodrich formation by Ojakangas (1994). The basal quartzites at both these localities appear to rest unconformably on Archean basement. The quartzites range from thickly to thinly bedded, with locally well developed planar and trough cross bedding. Quartzites in the Baraga basin are typically arkosic with conglomerate lenses. Ojakangas (1994) proposed that the Goodrich quartzites were deposited in a tidal environment. In the Baraga Basin, the Goodrich formation ranges in thickness from less than a meter in the eastern portion of the basin, to approximately 40 m in the western portion of the basin (Nelson, 2006).

I interpret widely scattered outcrops of similar appearing quartzite exposed along the margins of the Archean to the south and east of the BIC intrusion as equivalents of the Goodrich quartzite described above. However, in most places they appear to be in fault contact with the Archean. Klasner and others (1991) interpreted strongly foliated, quartz rich schists along the north side of Plumbago Creek in the Taylor mine area (fig. 2) as mylonitic textured Archean gneiss. I have examined some of these outcrops and feel they could, in part, be strongly foliated arkosic Goodrich quartzite. The proximity of the sheared "quartzite" with iron formation exposed along the banks of Plumbago Creek has potential stratigraphic implications in the Taylor mine area.

The Goodrich formation is overlain by the Michigamme formation, the uppermost formally recognized formation in the Baraga Group. Leith, et al (1935) divided the Michigamme formation into three principle members which, in ascending order are: the Lower Slate member, the Bijiki iron formation, and the Upper Slate member. Kennecott geologists have generally used this nomenclature for describing stratigraphic relationships in the Baraga Basin. However, in the western portion of the Baraga Basin, the Goodrich formation quartzites are immediately overlain by a thin interval (typically less than 20m thick) of inter-bedded chert and iron rich carbonate. Ojakangas (1994) suggested that this cherty horizon may be the equivalent of the Bijiki iron formation and that the Lower Slate member is missing in parts of the Baraga basin. However, Kennecott geologists believe this is a separate unit below the Lower Slate member and informally refer to it as the Chert Carbonate member. That informal designation is used in the rest of this field guide and in figure 2.

William Cannon (personal communication) has identified layers with accretionary lapilli, pumice grains and, at one location, quartz grains, with shock lamellae from bedrock exposures and core samples of the Chert Carbonate member in the Baraga Basin. Cannon has proposed that these are ejecta from the 1850 Ma Sudbury impact event and correlated them with other ejecta horizons previously identified in Ontario and Minnesota (Addison et al, 2005). Kennecott drill hole 07BIC-033, the deepest hole completed at the BIC prospect, intersected intervals with probable accretionary lapilli and pumice fragments (Cannon, personal communication) in cherty rocks starting at a depth of 586 m. The likely presence of the Sudbury ejecta layer in the BIC drill hole provides confidence that the more deformed rocks in the southwestern portion of the Baraga basin (south of the L'anse thrust fault in figure 2) are stratigraphically correlative with the rocks in the northern portions of the Baraga Basin.

The Chert Carbonate member and Sudbury ejecta layer is overlain by dominantly black to dark gray, thinly bedded, meta-siltstone and pelite in the Baraga Basin. The pelitic rocks are often graphitic and sulfide rich and contain only minor intervals of fine-grained greywacke. As mentioned above, Kennecott geologists believe this is the Lower Slate member of the Michigamme formation. This siltstone-pelite dominated interval increases from 20-90 m in the northern part of the Baraga Basin to thicknesses I speculate might be greater than 200 m in the vicinity of the BIC intrusion. However, structural complexities and insufficient drilling make accurate determinations of the thickness of this sequence currently impossible in much of the southern portion of the Baraga Basin.

In the Taylor mine area (stop 3-fig.2) the Lower Slate member is overlain by the Bijiki iron formation. The Bijiki iron formation is primarily comprised of thinly bedded, black and white chert with lesser siltstone, iron carbonate and iron oxides (Ojakangas, 1994). In the immediate Taylor mine area the Bijiki iron formation ranges from 20-80m in thickness (Ford Motor Company reports).

A Kennecott Exploration drill hole, ALB95-3, located approximately 2.7km west of the Taylor mine (fig. 2), intersected 280 m of banded iron formation, with lesser intervals of graphitic slate, starting at a depth of 110 m and continuing to the bottom of the hole. Bedding angles to core, along with the lack of any compelling evidence of fold or fault repetition, suggest that this is likely to be close to a true thickness. A second hole, ALB95-2, collared 1.1 km further to the west, intersected 194 m of iron formation. Both holes were terminated while still in iron formation so the total thickness of iron formation at this location is unknown. Kennecott geologists believe the iron formation in both holes is the Bijiki indicating a rapid westward thickening of the unit. This thicker part of the Bijiki is within a rhomb shaped magnetic and gravity high. The rapid westward thickening of the iron formation, and shape of the coincident geophysical anomalies, might be evidence of a fault bounded, second order basin that formed during deposition of the Lower Slate and Bijiki iron formation.

The BIC intrusion cross cuts an approximately 15km long linear magnetic anomaly. Drilling and mapping by Kennecott geologists has confirmed that the linear magnetic anomaly is caused by abundant pyrrhotite in graphitic sediments. The sediments contain numerous thin bands of contorted quartz and 0.5-1cm thick bands and lenses of semi-massive pyrrhotite and pyrite with minor sphalerite and chalcopyrite. The ratio of pyrrhotite and pyrite varies considerably along strike, and within a drill intersection, significantly affecting its magnetic susceptibility. Similar sulfide rich sediments are seen immediately below the Bijiki iron formation at the Taylor mine and in a 25-35m interval immediately above the Bijiki iron formation in drill holes ALB95-2 and ALB95-3 (pyrite rich in hole ALB95-3 and pyrrhotite rich in hole ALB95-2). The author proposes that these sulfide rich, variably magnetic sediments are the continuation of the Bijiki iron formation member northward into the BIC area. However, this important marker horizon has not been identified anywhere else in the northern part of the Baraga basin.

The Bijiki member is overlain by the Upper Slate member in the Taylor mine and BIC prospect areas. The Upper Slate member contains a significant percentage of greywacke inter-bedded with siltstone and pelite distinguishing it from the Lower Slate member. Ojakangas (1994) reported that greywacke beds made up 18% of a measured section in the Silver River north of the BIC intrusion. The greywacke beds are commonly graded and contain rip ups and other features indicative of deposition by turbidity currents.

<u>Baraga-Marquette Dyke Swarm</u>

The Baraga-Marquette dyke swarm is comprised of more than 150 diabase dykes (Green and others, 1987). The primarily east-west trending dikes form a belt that extends from the northern edge of the Baraga basin at least 75 km southward into southern Marquette County. Although most dykes in the swarm are less than 30 m thick, individual dykes are up to 185 m thick and can be traced for up to 59 km (Green et al., 1987).

The majority of the known dykes are reversely polarized, forming prominent magnetic linear anomalies on magnetic maps. None of the diabase dykes have been dated. However, the measured diabase dyke paleomagnetic pole position in the Marquette area is virtually identical to that of reversely magnetized intrusions from the Thunder Bay area (Wilband and Wasuwanich, 1980). Sutcliff (1987) reported an age of 1109ma for the reversely polarized Logan sills in the Thunder Bay area.

The dykes typically have subophitic to diabasic textures and contain 50-70% plagioclase, 30-50% clinopyroxene and 1% or less olivine and Fe-Ti oxides. Most dykes are relatively fresh with little sign of alteration (Wilband and Wasuwanich, 1980). Most of the reversely polarized dykes have high TiO_2 (3-5%), P_2O_5 (0.30-0.55%) and <15% Al_2O_3 (Wilband and Wasuwanich, 1980).The dykes also typically have high Cu (300-500ppm) and low Ni (<100ppm) contents (Kennecott data).

Interestingly, no reversely polarized dykes are evident in magnetic data sets north of the Falls River thrust fault (fig. 2). This might suggest that the fault played some role in localizing the reversely polarized dykes of the Baraga-Marquette dyke swarm.

The BIC Intrusion

The BIC intrusion is located about 35km southwest of Eagle and 8km southeast of the town of L'anse, Michigan. The intrusion forms a prominent hill approximately 1100m long by 400m wide. Mapping, geophysics and drilling indicate the intrusion has roughly the same dimensions as the hill at bedrock surface (fig. 3). Although not well constrained along much of the intrusion, based on the drilling completed, the intrusion appears to be generally V shaped in cross section. Drilling and mapping in the eastern portion of the intrusion suggest the southern margin of the intrusion dips moderately to the north (fig. 4). Knowledge of the northern contact is limited, but it appears to be steeply, south dipping.

A much smaller, shallow bowl shaped intrusion, referred to as Little BIC, was located just to the northwest of the BIC intrusion during 2006 drilling (fig. 3). The smaller intrusion is comprised mostly of relatively olivine rich lithologies very similar to those seen along the base of the main BIC intrusion. This smaller intrusion could be a fault offset of the larger BIC intrusion, or possibly a separate intrusion. The best mineralized intersections in drilling completed through 2007 have primarily come from this smaller intrusion.

Unlike the intrusion hosting the Eagle ore body, the BIC intrusion is distinctly layered. Core logging, thin section work and very limited geochemistry show that the BIC intrusion can be subdivided into three principal units; an upper coarse-grained gabbro, a middle unit comprised of fine-grained gabbro and feldspathic clinopyroxenite, and a lower unit of feldspathic wehrlite and olivine melagabbro. All three units thicken toward the center of the intrusion and thin toward the margins.

The following descriptions of the units are summarized from core logs and observations of outcrops and hand samples. Most of the descriptive mineralogy is taken from unpublished petrography reports prepared for Kennecott Exploration and Kennecott Minerals by Rod Johnson (2007) Steve Hauck (2002), and Bob Barnett (1995).

<u>Upper Unit - Gabbro</u>

The upper gabbro is the thinnest unit with no drill intersections exceeding 75 m (no upper contact has been located so this is only a minimum total thickness). It is exposed in a few scattered locations on the top of the hill. The best exposures are along the drill roads on top of the hill in the eastern portion of the Intrusion.

The upper gabbro is an altered, medium to coarse-grained, oxide gabbro with 55% lath like plagioclase and 35% prismatic or granular clinopyroxene. The gabbro contains up to several percent titanomagnetite, minor apatite and trace olivine. The upper gabbro is moderately to strongly magnetic.

Strong alignment of plagioclase laths, which can be up to 2cm in length, and prismatic clinopyroxnene creates a foliation in the gabbro in places. In other places, the crystals radiate, creating a stellate pattern. Small patches of granophyre are present in drill core and outcrop.

The upper gabbro is moderately to intensely altered with plagioclase variably altered to sericite and clinopyroxene altered to amphibole and chlorite. Very fine grained hematite coats some plagioclase giving it a pinkish color and titanomagnetite is altered to martite and maghemite. Pyrite occurs as disseminations and rare veins (Hauck, 2002).

Football size and shape pods of strong light green, epidote rich rock are common in outcrop and drill core of the upper gabbro. The pods, which have sharp contacts, can form up to 5% of some outcrops. The shape, size and distribution of the pods suggests that they might be preferentially altered xenoliths or autoliths.

<u>Middle Unit-Gabbro/Clinopyroxenite</u>

The middle unit is comprised of gabbro and clinopyroxenite which forms 3-10m high cliffs around the perimeter of the hill. The middle unit is by far the best exposed unit at the BIC prospect. Intersections in drill core of the middle unit reach 100m in drill holes in the eastern half of the intrusion but it appears to thin to the west.

The unit is comprised of fine-grained, equigranular gabbro and feldspathic clinopyroxenite. The upper few meters of the unit is a fine-grained, strongly magnetic equigranular, oxide rich, cumulate textured gabbro with 40-50% granular clinopyroxene and 20-50% granular titanomagnetite and minor ilmenite. Plagiclase content varies, but is typically less than 40% in this oxide rich part. Biotite and amphibole are minor components in the upper portion of the unit. This magnetite rich interval is present in most holes and creates a distinctive spike in magnetic susceptibility profiles in most BIC drill holes (a magnetic profile is shown for hole BIC02-02 in figure 4)

Magnetite content decreases rapidly with depth in the middle unit and most of the unit below the first few meters is weakly to non-magnetic. Clinopyroxene content increases downward and in the eastern portion of the intrusion much of the lower part of the middle unit is fine-grained, cumulate textured, feldspathic clinopyroxenite. The presence of cumulate clinopyroxenite is suspected in the western portion of the intrusion but not yet confirmed by thin section work.

Alteration is similar to that seen in the upper gabbro with plagioclase largely altered to sericite, carbonate and actinolite and pyroxene is variably altered to chlorite, carbonate and amphibole.

Fine-grained, disseminated chalcopyrite and trace bornite is found through out the unit, generally in trace amounts, but locally up to 0.5%. Minor pyrite and sphalerite are present in western outcrops of the middle unit, in addition to chalcopyrite.

Lower Unit- Wehrlite/Olivine Melagabbro

Unlike the upper two units, which contain only very rare olivine and orthopyroxene, the lower unit is relatively olivine rich and has up to 5% orthopyroxene in some thin sections. The lower unit is poorly exposed, with just a few outcropings along the south side and none on the north side. The unit is best exposed on the west end of the hill. Drilling indicates it is the thickest of the three units and has a thickness of greater than 200 m in drill hole BIC02-02 (fig 4).

The upper portion of the lower unit is comprised of fine grained, moderately magnetic, feldspathic wehrlite and olivine melagabbro with 35-60% cumulate olivine, 10-20% clinopyroxene, 10-34% plagioclase and minor sulfide. Clinopyroxene is either granular or poikolitic on olivine and plagioclase is poikolitic on both olivine and clinopyroxene. Titanium rich phlogopite and amphibole are also minor (1-2%) primary mineral phases. Chromite occurs as grains within olivine and minor titanomagnetite and ilmenite occur as single or composite grains, often subpoikolitic on clinopyroxene.

Barnett (1995) reported olivine compositions for outcrop samples of the lower unit that ranged from fo76 to 83. These values closely overlap with the range of fo76 to 85 reported for olivine melagabbro at the Eagle deposit (Ding, 2008). In most holes, olivine content decrease with depth in the lower unit, while clinopyroxene, plagioclase and sulfide increase. In the eastern portion of the intrusion, this change in mineralogy is accompanied by an increase in grain size in the lower 50m of the intrusion.

Alteration is moderate to severe in the lower unit with olivine partially to completely altered to either iddingsite or serpentine and fine-grained magnetite. Both plagioclase and clinopyroxene are variably altered to chlorite and carbonate. The alteration tends to turn everything green in the most altered samples, often making visual determination of the primary mineralogy difficult in hand and core samples.

Contact metamorphic Aureole

Meta-sedimentary rocks peripheral to the BIC intrusion show the effects of low pressure contact metamorphism. Johnson (2007) studied thin sections cut from drill core samples of meta-sediments peripheral to the BIC intrusion. He divided metamorphic assemblages in the meta-sediments into a proximal granoblastic hornfels, a more distal porphroblastic spotted hornfels, and a regional green schist assemblage.

Within two to three meters of the contact of the intrusion, primary structures and foliations in the meta-sediments are very poorly preserved. The regional metamorphic assemblage is overprinted by a granoblastic assemblage of cordierite, quartz, biotite, vesuvianite and sphene +/- andalusite, sillimanite, kspar and plagioclase. Scattered small pods and veins of coarser grained k-spar and quartz within the granoblastic hornfels suggest localized partial melting of the meta-sediments in close proximity to the intrusion.

The granoblastic hornfels grades outward into spotted hornfels which in some drill holes can be recognized in the meta-sediments10 to 15m from the contact with the intrusion. The spotted hornfels is characterized by the growth of small (<0.5 mm) porphyroblasts in phyllosilicate rich beds. Johnson (2007) reported cordierite, andalusite and sillimanite as the principal prophyroblasts in the spotted hornfels. Johnson also reported that much of the high temperature metamorphic assemblage has been overprinted by a retrograde assemblage with porphyroblasts replaced by chlorite and white mica and biotite by chlorite.

Mineralization

Three types of sulfide mineralization related to the BIC intrusion have been recognized: disseminated chalcopyrite-pyrite mineralization in the middle unit, copper and PGE rich disseminated sulfide mineralization in the lower unit and thin bands of "Eagle like" massive sulfide in the hornfels beneath the intrusion. However, exploration work completed to date at BIC has not yet identified any significant Cu-Ni-PGE resource.

Fine-grained chalcopyrite with trace pyrite, sphalerite and rare bornite is disseminated throughout the middle unit. Limited sampling of this interval in drill hole BIC01-01 gave Cu values up to 0.16% over 1.5 m. However, Ni values were all below 500ppm and Pt and Pd values were all at, or below, the detection limits (Kennecott Exploration data).

Disseminated sulfides are erratically distributed throughout the lower unit In the BIC intrusion. However, sulfide abundance seldom exceeds 5% in most of the drill tested portions of the intrusion. The greatest abundance of sulfide is typically located within a 3-4m interval 1-2m above the base of the intrusion. In the Little BIC intrusion, the abundance of disseminated sulfides reaches 10% over short intervals. Continuous intervals with >4% disseminated sulfides exceeding 20 m have been intersected in some drill holes at Little BIC.

Sulfides in the lower unit are comprised of irregularly shaped, composite grains of pyrrhotite, chalcopyrite and pentlandite that are subpoikolitic on olivine, clinopyroxene, plagioclase, amphibole, ilmenite and titanomagnetite (Hauck, 2002). Cubanite occurs both as lamellae in chalcopyrite and as irregular grains. Recalculating the metal contents of disseminated sulfides to 100% sulfide, BIC and Little BIC disseminated sulfide metal tenors in the lower unit average 12.77% Cu, 5.88% Ni, 10.5ppm Pt and 12.91ppm Pd (avg. 109 samples with 0.9-10% S). In contrast, disseminated sulfides in the Eagle deposit recalculated to 100% sulfide average 6.24% Cu, 6.39% Ni, 1.5ppm Pt and 0.9ppm Pd (avg. 2350 samples with 0.9-10% S). The significantly higher Cu:Ni ratio and greater PGE content of BIC disseminated sulfides compared to Eagle disseminated sulfides suggest a greater silicate melt to sulfide melt ratio (R factor) at BIC.

Thin (<1m) bands of massive sulfide occur in the hornfels within a few meters of the base of the Little BIC intrusion, and in a few holes in the western portion of the BIC intrusion. Two samples of massive sulfide from hole 06BIC-007 (Little BIC intrusion- fig.3), selected to maximize sulfide content, averaged 2.72% Cu, 6.02% Ni, 1.8ppm Pt and 3.1ppm Pd (avg. 35.8% S). The significantly lower Cu and PGE tenors of the massive sulfides hosted in the meta-sediments suggests that they were not directly formed by gravitational settling of the overlying disseminated sulfides. Interestingly, the massive sulfides at BIC have metal tenors and Cu:Ni ratios very similar to Cu poor massive sulfides at the Eagle deposit.

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Field Trip Stops

The first four stops on this trip are intended to highlight the variety of sediments that comprise the Paleoproterozoic Baraga Group in the vicinity of the BIC intrusion. They also provide an opportunity to see and discuss some of the structural complexity in this area. At stops 5 and 6 we'll examine exposures of the BIC intrusion. Stop 7 will be at the Kennecott Minerals Company core shed near Negaunee, Michigan. Here we'll have an opportunity to look at drill core form the BIC intrusion including mineralized intervals that are not exposed in the field. The location of field trip stops 1-6 are shown on figure 2. The locations of stops 5 and 6 are also shown on the more detailed BIC geology map. GPS coordinate locations provided for the stops are in UTM (Universal Transverse Mercator), zone 16. The datum is Nad 83.

All of the field trip stops, except stop 1, are in areas of privately owned surface. Permission from the surface owners is required before accessing these areas.
Some of the stops are along rivers and streams with high, often slippery banks and with potentially poor footing. Caution should be used in walking around these areas. Steep, cliff like outcrops are present in the vicinity of Stop 6, they provide great views but please stay well back from the edges.

Stop 7-1 Canyon Falls on the Sturgeon River
(UTM coordinates 386938E 5164275N)

Good exposures of the Goodrich formation quartzites are exposed along the Sturgeon River at this location. To access the area, park at the Sturgeon River roadside park on the west side of US Highway 41 and follow the marked hiking trial south about 600m to the falls overlook.

This area was a stop on a previous ILSG field trip led by Bill Cannon and John Klasner in 1972. The following stop description is an excerpt from that field guide.

"This stop illustrates an anomalous structural style in that the rocks are relatively nonfolded as compared with the deformation style of nearby Precambrian X metasedimentary rocks, Here the quartzites, composed of quartz grains in a clay matrix with chlorite porphyroblasts, show very gentle N 70° W trending monoclinal folds. Ripple marks and sole marks are common on bedding surfaces. The more argillaceous layers show the development of a N 70° W cleavage"

Ojakangas (1994) has correlated the thinly layered quartzite at this location with the Goodrich formation.

Stop 7-2 Conglomerates on top of the Bijiki iron formation near the Taylor Mine.
(UTM coordinates 388973E 5168500N)

The stop is at rubble (subcrop) along the north side of a small drainage into Ogemaw Creek about 30m southeast of Old Hwy 41 (note: Old hwy 41 from the turn off of US highway 41 to the Taylor mine turnoff is a poorly maintained road that is often rutted and muddy and occasionally flooded.

Klasner (1972) mapped a horizon of poorly exposed conglomerate and greywacke along the top of the Bijiki banded iron formation at this location. The reddish sandstone contains scattered matrix supported clasts of chert up to 10cm across. Drilling by Kennecott a few km to west of this location suggests that the Bijiki iron formation rapidly increases in thickness to the west. Perhaps, these conglomerates are additional evidence of a higher energy environment associated with the formation of a fault controlled sub-basin to the west.

Stop 7- 3 Taylor mine site
(UTM coordinates ~ 389660E 5169000N)

The Taylor Mine site can be accessed by walking east from old hwy 41 along the old Taylor mine road. A trail to the north, along an old rail grade just before the old Taylor mine pit, leads to several good bedrock exposures.

The Taylor Iron Co. shipped 32,970 tons of iron ore from the Taylor mine between 1880 and 1883 (Lake Superior Iron Ore Association, 1952). The property was explored by Ford Motor Company for iron ore during the 1950's and 1960's. Additional drilling was carried out on the property in the 1970's as part of a regional uranium exploration program. John Klasner (1972) produced a detailed map of the mine area as part of his Ph.D. dissertation at Michigan Technological University. Kennecott acquired mineral title to the property as part of the purchase of all of the Ford Motor Company mineral title holdings in the Upper Peninsula.

The mine site provides good exposures of the Lower Slate and Bijiki members of the Michigamme formation and diabase dykes of the Baraga-Marquette dyke swarm. Well exposed folds also contrast with the very weakly folded quartzite at stop 1. Klasner (1972) describes the folds at the Taylor mine as "asymmetric with slight overturning to the north and a recognizable S_1 axial plane foliation. The folds have an amplitude of 400 feet (122 m) and a period of 600 feet (183 m). Minor folds are superimposed on the larger folds"

Stop 7-4 Taylor Creek (optional)
(UTM coordinates 390436E 5170300N)

Good exposures of probable Upper Slate member of the Michigamme formation are found downstream along Taylor Creek from where old hwy 41 crosses it. However, in many places the banks of Taylor Creek are very steep and rocky. Access to this stop will depend on how high spring run off water level is.

The banks of Taylor Creek at this stop are steep and the footing can be poor. Use caution when climbing down to view the exposures along the creek.

Taylor Creek is within the Falls River slice, the allocthon proposed by Gregg (1993) south of the Falls River thrust fault (see fig. 2). Deformation evident in the bedrock exposures along Taylor Creek is different than that seen at either the Taylor mine or further north in the Baraga basin. In Taylor creek, small scale folds, where visible, are often nearly recumbent. In pelitic horizons, S_1 foliations typically dip gently southward and are affected by a well developed crenulating cleavage associated with a second generation of folds.

Stop 7-5 Exposures of the Lower and Middle Units on the west end of the BIC intrusion
(UTM coordinates 396027E 5174514N)

The west end of the BIC intrusion is accessible by hiking eastward from the Indian road along a series of old logging trails. The best exposures are located just below the top of the hill. **The surface and mineral title are held by Kennecott Minerals Company at this stop and permission is required to access the area.**

At this stop, a natural flat terrace on the west facing slope of the prominent hill held up by the BIC intrusion, marks the unexposed contact between the Lower and Middle units of the BIC intrusion. Outcrops down slope from the terrace are comprised of rocks that range in composition from feldspathic werhlite to olivine melagabbro. They contain minor disseminate pyrrhotite, chalcopyrite and pentlandite. Nearly complete replacement of plagioclase by secondary minerals makes accurate determinations of modes very difficult in most hand samples of this unit. The Lower Unit of the BIC intrusion is compositionally similar to the olivine rich melagabbro that hosts much of the mineralization at the Eagle Ni-Cu-PGE deposit in the eastern end of the Baraga basin.

Exposures upslope from the terrace are of equigranular, locally ophitic textured gabbros of the Middle unit. Unlike the Lower unit, neither olivine nor orthopyroxene appear to be present in the Middle unit. Minor pyrite and chalcopyrite are found as disseminations through out the unit. Hematite locally coats plagioclase giving it a pinkish hue.

The contact between the olivine rich Lower unit and the olivine free Middle unit is relatively sharp. It is currently unclear if the change represents closed system fractionation or multiple pulses of different magmas. There is currently no recognized analog for the BIC intrusion Middle or Upper units at Eagle.

More detailed descriptions of the units at BIC can be found in the first part of the guide.

Stop 7-6 Upper Unit exposures on the east end of the BIC intrusion.
(UTM coordinates 397013E 5174477N)

The east end of the BIC intrusion is accessible by a series of logging and drill roads starting off the Silver River road north of the intrusion. The last part of the road to the top of the hill is typically deeply rutted and often not drivable. Walking the last part is recommended. **Permission from Kennecott Minerals Company is required before accessing this stop.**

Glaciated exposures of the medium to coarse-grained oxide gabbro that comprise the Upper unit of the BIC intrusion are present in, and alongside the drill road going up the eastern end of the hill. Exposures of the gabbro near the top of the hill contain football size and shape patches with intense epidote alteration. The boundaries of the intensely altered rock are very sharp. It is currently uncertain if these are intensely altered xenoliths or cross sections of sub-parallel "pipe like" zones of hydrothermal alteration.

Stop 7-7 Kennecott Minerals Company core shed.

The Kennecott core shed is located 2.6 miles east of the town of Negaunee. Turn north off of US Highway 41 at the blue TV 6 building (across from the Michigan Police post) on to the old airport road. Follow the road around the curve to the west and proceed through the gate. The core buildings are the long sheds on the south side of the road just past the gate.

Core from the BIC and Little BIC intrusion will available for viewing and discussion.

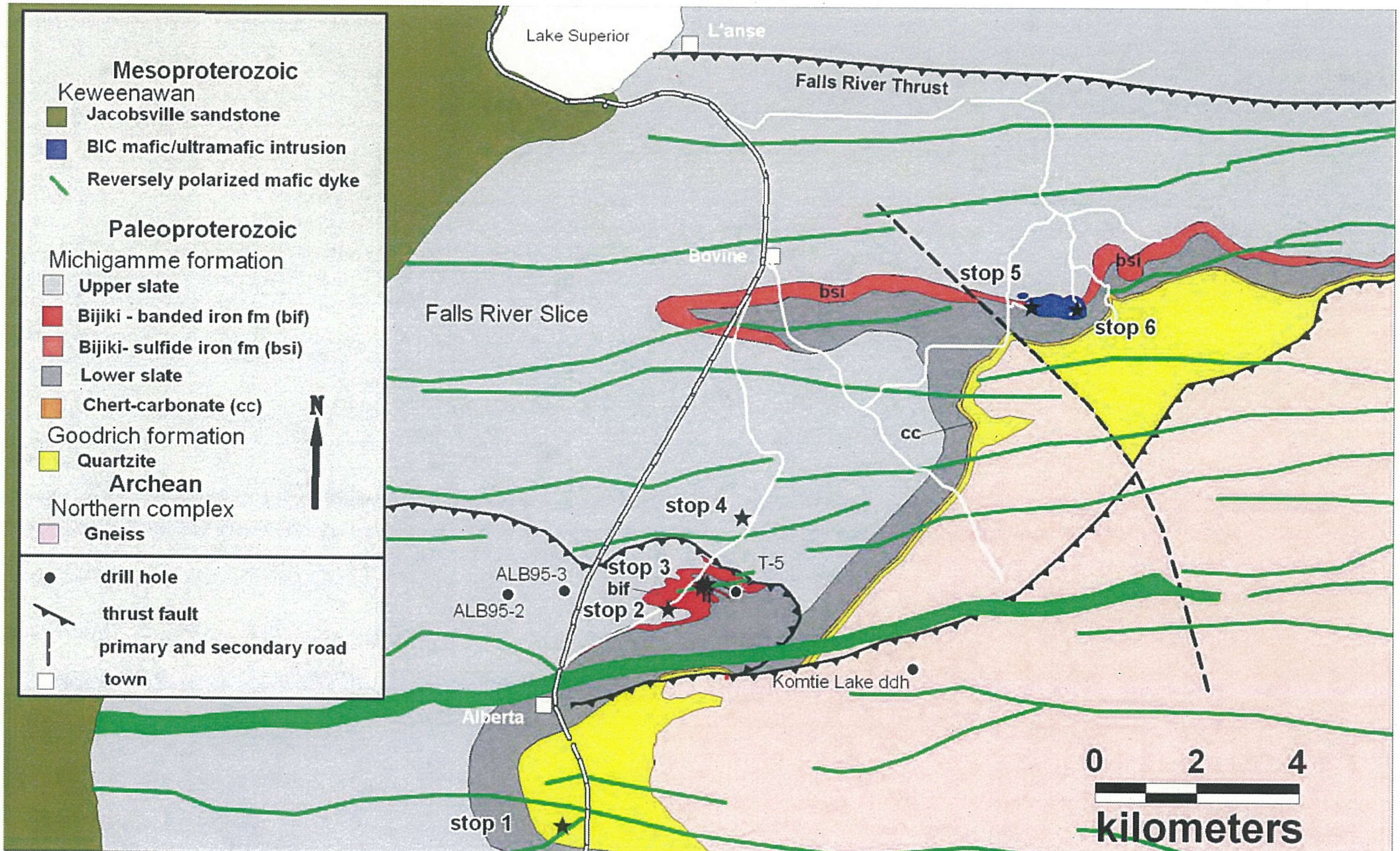

Figure 2) Geology map of the southwestern portion of the Baraga Basin showing the location of field trip stops. Modified from Klasner (1972), Klasner and others (1991) and Cannon (1977)

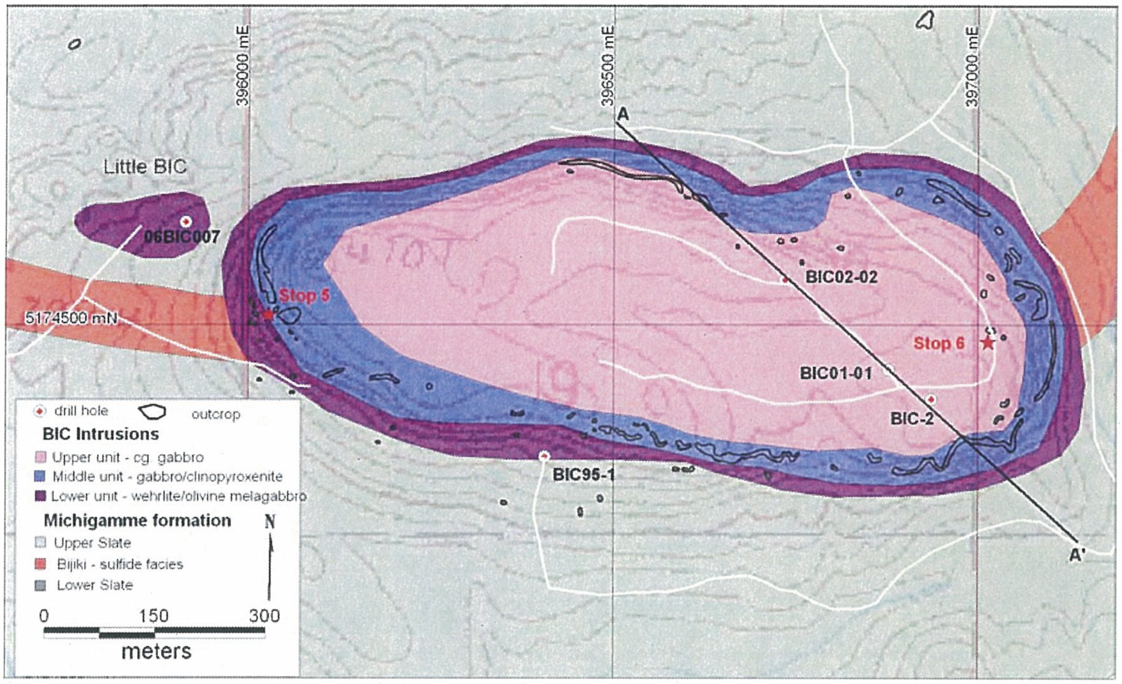

Figure 3) Geology map of the BIC intrusion showing the location of field trip stops 7-5 and 7-6.

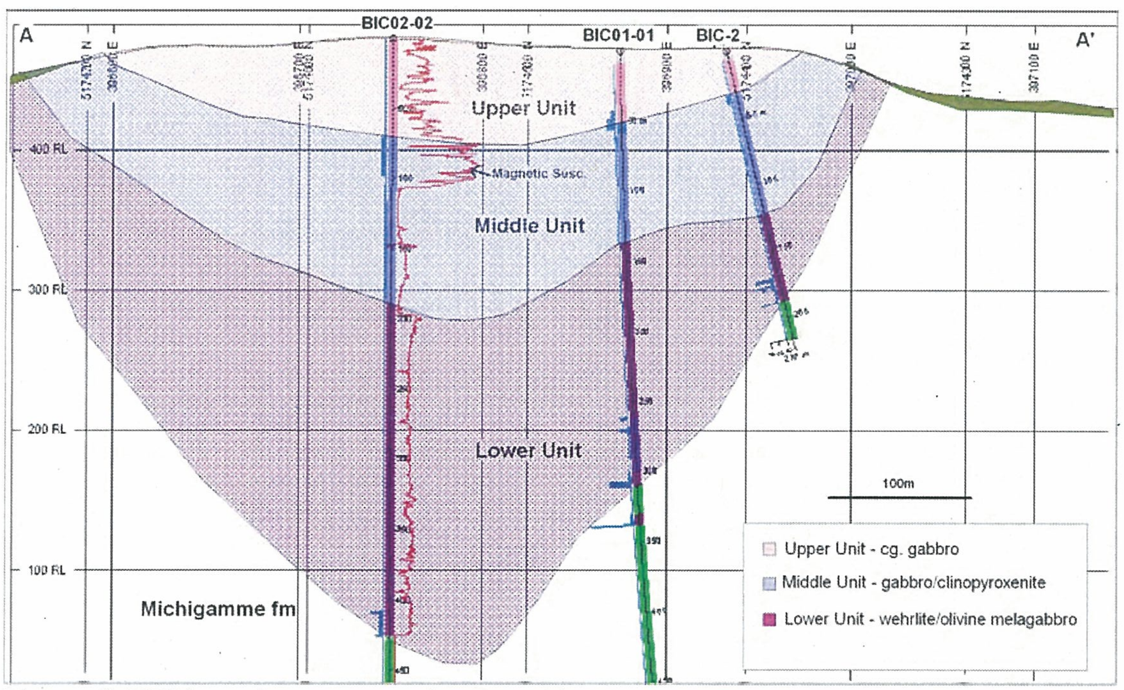

Figure 4) BIC intrusion cross-section A to A'